



STEP BY STEP
ROOT CANAL TREATMENT

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STEP BY STEP **ROOT CANAL TREATMENT**

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Step by Step Root Canal Treatment

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***Dedicated
to our parents
and
teachers***

Foreword



भारतीय दन्त परिषद

DENTAL COUNCIL OF INDIA

(CONSTITUTED UNDER THE DENTISTS ACT 1948)

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The dental profession has grown by leaps and bounds in the past decade. This is not only seen by the emergence of newer technologies and better treatment capabilities but is also reflected by the increased awareness about dental health by the common man. The biggest change that we see today is the patients 'demand' to save the most painful of teeth. The only cure in 90 percent of such cases exists by the use of root canal treatment procedures.

The handbook *Step by Step Root Canal Treatment* is a gallant attempt by two young authors to simplify and yet present in a stepwise manner the routine diagnostic as well as biomechanical procedure involved in treating canal infected tooth. The book is well illustrated and I think would act as a ready reference guide to the young dental practitioners of today.

I take this opportunity to wish them all success and sincerely hope that they would continue to support the dental profession by publishing such books, which are clinically oriented and useful in the day-to-day practice of dentistry.

My compliment and good wishes to the young and dynamic authors.

A handwritten signature in black ink, appearing to read 'A. Kohli', with a long horizontal stroke extending from the end of the signature.

Anil Kohli

Preface

This book has been written with an objective of filling the lacunae left between the concepts taught by the various endodontics textbooks and actual practice of clinical endodontics. This handbook will specifically meet the requirements of a general dental practitioner.

The chapters have been arranged specifically for better understanding and provide a step by step approach to understanding the need and procedure of actual root canal treatment. It is actually **A Step by Step** approach to root canal treatment. It is adequately illustrated both with diagrams and clinical pictures wherever necessary.

It is quite possible that there are errors of omission and commission in this attempt. We would be sincerely grateful to readers for their suggestions to improve the book.

Vivek Hegde
Gurkeerat Singh

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The contributions of Dr Vinu Nair, Dr Shyju Neyyan and Dr Akanksha Gulati deserve special mention, towards the compilation of this book. Our thanks to Mr Abrar, Mr Shahnavaz and Mr Shyam for working overtime during the preparation of this book.

We appreciate Mr Imran for featuring in the photographs of the chapter on diagnosis.

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Chapter 1

Introduction

Toothache has affected mankind for time immemorial. The Chinese as well as the Egyptians have left records describing caries and dental abscesses. The Chinese considered these to be caused by white worms residing within the teeth. Their recommended treatment of this ailment using arsenic is well-documented.

The Greeks and Romans had tried cauterizing the pulpal tissues using hot needles or boiling water. Abscessed teeth were treated with leaches. Providing drainage, by drilling into the pulp chamber causes relief in pain was known around the end of 1st century AD.

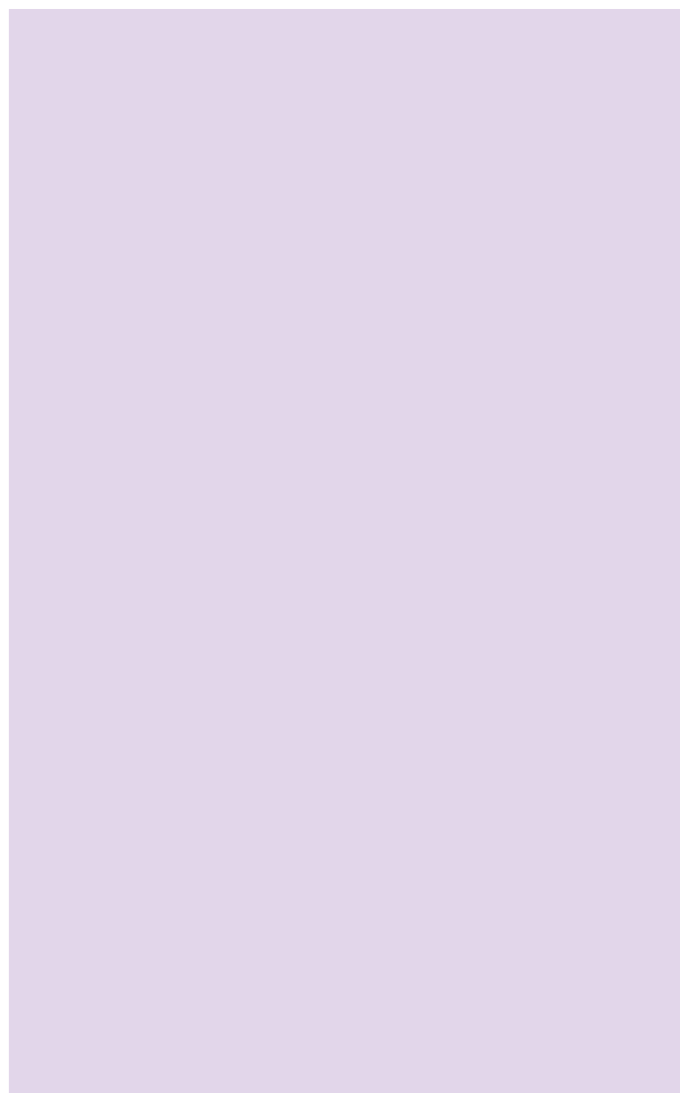
The pulpal anatomy was described as late as the 16th century. The use of open root canals to aid in the fabrication of dowel crowns aided the intentional devitalization of teeth. The use of 4% cocaine injection as a mandibular nerve block in 1884 and the discovery of X-rays in 1895, popularized root canal therapy further. In 1891, Otto Walkhof introduced CMCP and took the first dental radiograph in 1895.

It was only in the mid-1930's that the modern concept of root canal treatment started taking shape. There was an overall improvement in radiographs, anesthetics and procedures. The concepts of disinfection and apical seal were developed after well-documented cases were analyzed over the years. It was as late as the 1970's, with better quality material being available and more advanced knowledge of biology that the present day success story of the root canal treatment came to be written.

Putting it simply, “*Endodontics can be defined as the science for the prevention and treatment of apical periodontitis.*” This will include the steps undertaken to maintain the health of the vital pulp in the tooth, or the treatment of damaged or necrotic pulp in a tooth to allow the tooth to remain functional in the dental arch (Table 1.1).

Table 1.1: Scope of endodontics

- Diagnosis of oral/dental pain.
- Protection of the healthy pulp from injury-physical, chemical or bacterial.
- Pulp capping (direct or indirect).
- Pulpotomy.
- Pulpectomy.
- Root canal treatment.
- Surgical endodontics, including apicectomy, hemisection, root amputation and replantation.
- Post-endodontic restorations including post and core buildups, crowns, etc.



Chapter 2

Rationale for Endodontics

Any form of injury—physical, chemical or bacterial, to the calcified structures of a tooth or to its supporting structures is capable of producing changes within the pulp and peri-radicular tissues. These changes can be reversible or irreversible depending upon the:

- Duration of the stimulus,
- Intensity of the stimulus,
- Pathogenicity of the stimulus,
- General body resistance of the host,
- Health of the injured region.

Accordingly, it can be formulated that mild to moderate noxious stimuli can produce reversible inflammation. However, severe injury can cause irreversible inflammatory changes in the pulp.

It has been shown experimentally that the functional capability of a tooth depended NOT on the vitality of the tooth but on the integrity of the periodontal tissues surrounding it. It was as far back as in 1931, the concept of ‘hollow tube’ was proposed, which was experimentally validated in 1966. These experiments conclusively proved that root canals behaved like closed tubes; if they were infected with micro-organisms then the potential for repair was less favorable as compared to when the lumen is clean and sterile.

It was Fish in 1939, who experimentally proved that well-defined zones of infection were found in the bone surrounding foci of infection (Fig. 2.1). Four zones of reaction were.

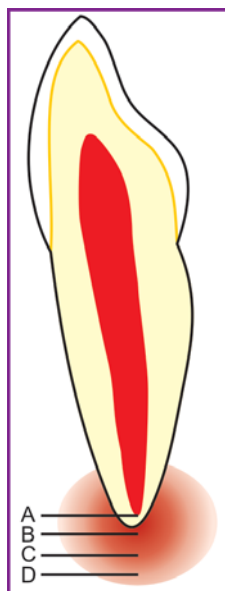


Fig. 2.1: Diagram showing the microorganisms in the root canal and the zones of infection. (A) Zone of infection, (B) Zone of contamination, (C) Zone of irritation, and (D) Zone of stimulation

- A. Zone of infection,
- B. Zone of contamination,
- C. Zone of irritation, and
- D. Zone of stimulation.

A. *Zone of infection:*

- Characterized by the presence of polymorpho-nuclear leukocytes.
- Can be said to represent the infected root canal. Thus, the root canal is the seat of infection.

- The microorganisms are rarely motile and generally do not move into the periradicular tissues by themselves.
- The microorganisms can multiply sufficiently to reach the periradicular tissues, or the byproducts of tissue necrosis can reach these areas, or they can be pushed beyond the apex mechanically (as in during root canal preparation).
- This zone represents confinement or an attempt at confinement of the bacteria made by the polymorphonuclear leukocytes.

B. *Zone of contamination:*

- Surrounding, around the area of infection.
- Characterized by the presence of round cell infiltration.
- Cellular destruction was observed in the zone.
- Bone cells die due to the effects of the toxins released from the zone of infection. Thus, lacunae appear empty.
- Radiographically seen as the initial radiolucency in the periapical region of an infected tooth.
- Prevalence of lymphocytes is seen.

C. *Zone of irritation:*

- Characterized by the presence of macrophages and osteoclasts.
- Irritation due to dilution of toxins.
- Low virulence or lesser microorganisms get destroyed as rapidly as they reach the periradicular tissues leading to the formation of a chronic abscess.

- If the microorganisms are sufficiently virulent or their number is more than that can be handled by the defense mechanisms a periradicular lesion results.
- The toxic products of the bacteria and necrotic pulp together with the proteolytic enzymes released from neutrophils help to form pus.
- Overall histological picture may be that of activity preparatory to repair.

D. *Zone of stimulation:*

- Characterized by the presence of fibroblasts and osteoblasts.
- Here, the microorganisms or their toxins are diluted enough to act as stimulants.
- Depending upon the reaction of the various tissues present here the infection might lead to the formation of granuloma (fibroblast activation), cyst (stimulation of the epithelial rests of Malassez), etc.

When root canal treatment is performed, it is supposed to destroy this reservoir of microorganisms and their toxin products. Even though the indications outweigh the contraindications for root canal therapy (Table 2.1), the importance of these contraindications cannot be overstressed so as to make this procedure more predictable and successful.

Effective elimination of bacteria from the root canals is achieved by instrumentation combined with irrigation. This is followed by complete obturation of the root canal system, producing an 'apical seal' which prevents any entry

Table 2.1: Indications and contraindications of root canal treatment*Indications:*

- All teeth whose pulp has suffered irreversible damage from physical, chemical or bacterial damage and are not contraindicated for treatment.
- Intentional treatment as part of other restorative or prosthetic restorations.

Contraindications:

- Teeth with insufficient periodontal support (Fig. 2.2).
- Teeth that have insufficient tooth structure remaining to warrant restoration, nonrestorable teeth (Fig. 2.3).
- Teeth with unfavorable canal anatomy, where proper instrumentation is not possible (Fig. 2.4).
- Teeth with massive internal (Fig. 2.5) or external (Fig. 2.6) resorption.
- Teeth with vertical fractures (Fig. 2.7).
- Non-strategic teeth, e.g. maxillary third molar with the mandibular third molar congenitally missing or lost (in a full complement maxillary arch).
- Inability of the dentist.
- Patient unable to afford the treatment.

of microorganisms from the canal to the peri-radicular tissues or vice versa. Permanent root filling is necessary to secure that bacteria do not re-enter the root canal space after chemo-mechanical preparation and disinfection. Another suggested function of the obturating materials included the entombment of the residual bacteria in the



Fig. 2.2: Insufficient periodontal support



Fig. 2.3: Non-restorable teeth

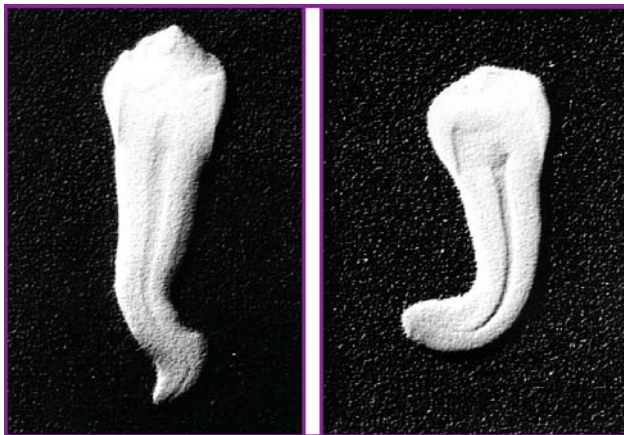


Fig. 2.4: Unfavorable anatomy (*Courtesy:* Dr Arun Khatavkar)



Fig. 2.5: Internal resorption (*Courtesy:* Dr Arun Khatavkar)



Fig. 2.6: External resorption



Fig. 2.7: Heavily restored mandibular molar with an unfavorable vertical fracture

root canal system so that they don't come in contact with living tissue in the periapical area and proliferate causing reinfection.

All root canal fillings must be protected by a coronal restoration of high quality to prevent bacterial contamination of the whole root filling. Although the clinical relevance of coronal leakage is not yet fully understood, it is obvious that a considerable part of the need for retreatment is caused by coronal leakage.

Chapter 3

Principles of Endodontic Treatment

The basic principles of root canal treatment are similar to those associated with any routine surgery. Certain procedures involved vary because of the anatomy of the canal system. These differences will get highlighted during the access cavity preparation and biomechanical preparation stages of the root canal treatment.

PRINCIPLE 1: ISOLATION

Isolation is ideally achieved by the application of a **rubber dam** (Fig. 3.1). The rubber dam equipment basically consists of:

1. Dam material
2. Punch
3. Clamp
4. Dental floss
5. Clamp forceps
6. Wedgets.

The frames can be placed on top (Fig. 3.2a) or below the dam (Fig. 3.2b).

Advantages of the Rubber Dam

1. Dry clean disinfected field.
2. Prevents aspiration or swallowing of medicaments or instrument.
3. Retraction of soft tissues.
4. Protects from drugs and irrigating solutions.
5. Provides a fluid seal from saliva.

6. The rubber dam safeguards against bacterial contamination from saliva and/or adjacent teeth as well as prevents the accidental swallowing of root canal instruments.



Fig. 3.1: Rubber dam kits



Fig. 3.2a: Frame on top of the dam

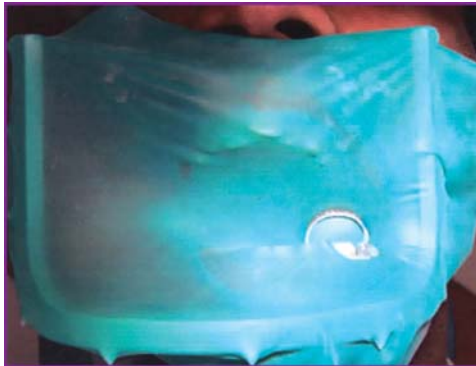


Fig. 3.2b: Frame below the dam

Fig. 3.2: Various methods of application of the dam frame

In clinical practice the use of rubber dam decreases overall chair-side time, increases efficiency and success rate of root canal treatment.

PRINCIPLE 2: STERILIZATION OF INSTRUMENTS

Sterilization

Sterilization involves the complete destruction of all microbes along with their spores.

Disinfection

Disinfection can be simply defined as the killing of microbes causing disease related to inanimate objects.

Teeth and the applied rubber dam should be thoroughly swabbed with a quick evaporating antiseptic, e.g. chlorhexidine, benzyl alkonium chloride, zephron, tincture iodine, etc (Fig. 3.3).

Instruments should be ultrasonically cleaned with a disinfectant (Fig. 3.4).

Autoclaving (Fig. 3.5) is the best and time-tested method of sterilization. It utilizes the principle of moist heat or steam under pressure for the purpose of elimination of microorganisms. This is done at 15 pounds pressure at 120 degree centigrade for a minimum period of 15 minutes.

Other methods commonly used for routine chair side use include:

- Cold sterilization using quaternary ammonium compounds, ethyl alcohol or isopropyl alcohol or glutaraldehyde.



Fig. 3.3: Antiseptics



Fig. 3.4: Ultrasonic cleaner (*Courtesy: Dr Naresh Thukral*)



Fig. 3.5: Autoclave (Courtesy: Dr Naresh Thukral)

However, cold sterilization is not effective against all microorganisms and the time taken by the agents to be effective is too long to be practically used on a day-to-day basis.

- Glass bead/hot salt/molten metal sterilization (Fig. 3.6).
- UV sterilizer (Fig. 3.7).
- Flaming.
- Laser sterilization.

Sterilization of various materials used in endodontics

<i>Material</i>	<i>Sterilization procedure</i>
Burs	Autoclave, hot salt sterilization
Broaches, files, reamers	Glass bead sterilizer or hot salt sterilizer for 5 seconds

Contd...

Contd...

Absorbent points and cotton pellets	Glass bead sterilizer or hot salt sterilizer for 10 seconds
Cement spatula	Pass it 3–4 times over the flame
Gutta percha	5.2% sodium hypochlorite for one minute
Silver cones	Pass it 3–4 times over the flame



Fig. 3.6: Glass bead sterilizer



Fig. 3.7: UV sterilizer

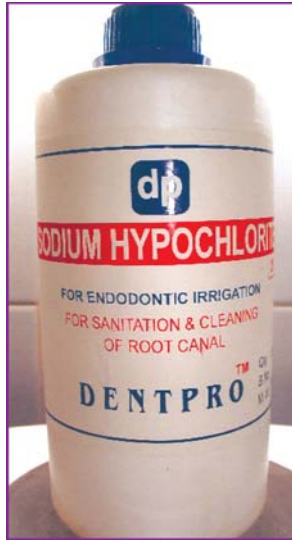


Fig. 3.8: Sodium hypochlorite irrigant

PRINCIPLE 3: DEBRIDEMENT

It is a basic principle of surgery that an infected wound must be cleaned mechanically. The root canal system is cleaned with sodium hypochlorite irrigant (Fig. 3.8). This irrigant is known to work best as a tissue solvent and anti-bacterial agent.

In all cases a combination of shaping and cleaning is advocated. Shaping is done mechanically with reamers and files. Mechanical instrumentation during shaping facilitated cleaning.

PRINCIPLE 4: DRAINAGE

When gross infection and swelling is present, an incision and drainage is advocated. To make the swelling fluctuant, warm water saline rinses can be advocated. At times to establish drainage through the bone, trephination (rotary drilling) may be performed.

PRINCIPLE 5:CHEMOPROPHYLAXIS

Antibiotics and painkillers may be given orally as adjunctive therapy during root canal procedures (Tables 3.1 and 3.2). Additional coverage of antibiotics as supportive therapy has to be given in patients suffering from systemic heart disease, immunosuppressive disorders or ailments that may medically compromise the health status of the patient (Table 3.3).

PRINCIPLE 6: IMMOBILIZATION

Splinting (Fig. 3.9) is done in some compromised cases to relieve occlusal forces. Efforts may also be directed at removing or reducing the occlusal forces on the compromised tooth by relieving contact.

PRINCIPLE 7:MINIMAL TRAUMA

Keep it simple and safe– “KISS principle.” This basically means that the root canal should be prepared using the minimum number of instruments with as less trauma to the surrounding tissues as possible.

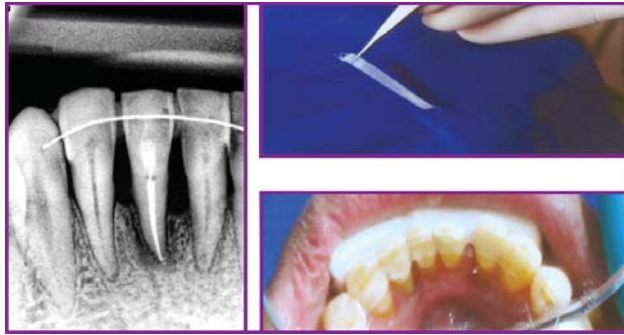


Fig. 3.9: Splinting of periodontally compromised teeth using multistranded braided wire or fiber splints

Table 3.1: Some useful antibiotics

- Amoxycillin capsules 250 mg
1 or 2 8 hourly, 3–7 days
 - Augmentin capsules, 375 mg or 625 mg
1 capsule 8 hourly, 3–7 days
 - Metronidazole tablets, 200 mg
1 or 2 tablets 8 hourly, 5 days
- Childs dose is a fraction proportional to his/her weight, calculated as:
- $$\frac{\text{Childs weight}}{150} = \text{fraction of adult dose}$$
- where, 150 is the average weight of an adult in pounds

Table 3.2: Some useful analgesics

Mild to moderate pain:

- Aspirin tablets, 300 mg

1 to 3 tablets 4–6 hourly, max. 4 mg/day

- Paracetamol tablets, 500 mg

1 to 2 tablets 6-hourly max. 4 mg/day

- Ibuprofen tablets, 200 mg

1 or 2 tablets 4–6 hourly, max. 2.4 mg/day

Moderate to severe pain:

- Dihydrocodeine tablets, 30 mg

1 tablet every 4–6 hourly, max. 1.8 mg/day

- Pethidine tablets, 25 mg

2 to 4, 4 hourly, max. 6 mg/day

- Tramadol tablets, 100 mg

1 tablet 6–8 hourly, max. 400 mg/day

Table 3.3: Infective endocarditis prophylaxis

- Amoxycillin oral powder, 3 gm sachet

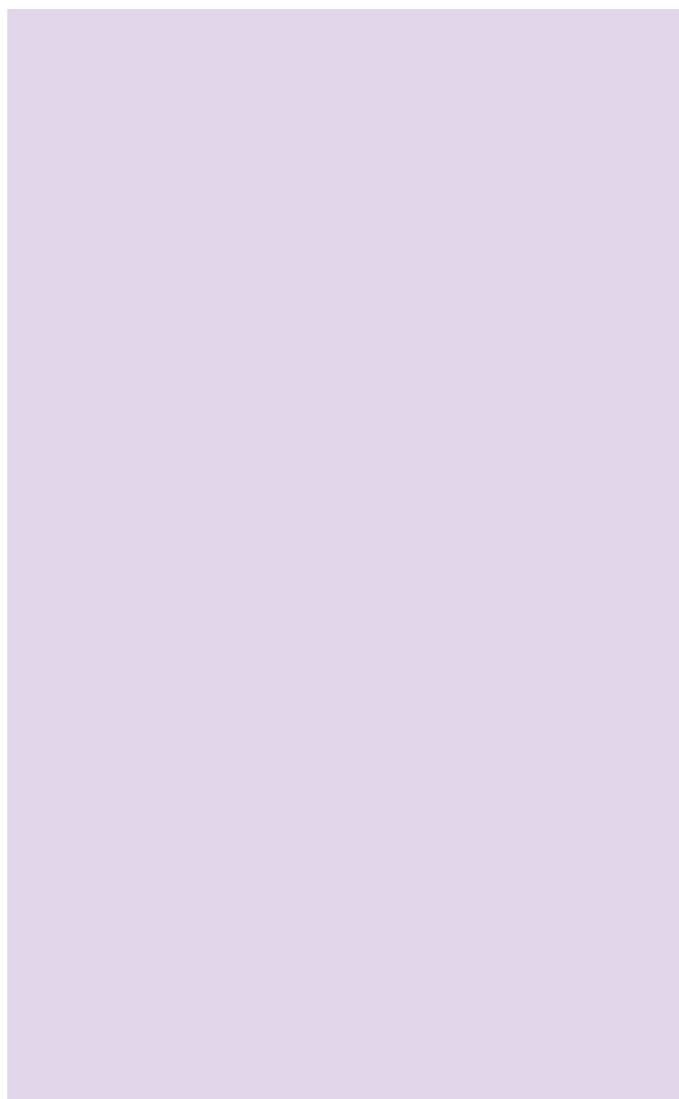
3 gm administered 1 hour preoperatively.

- Clindamycin capsules, 150 mg

600 mg administered 1 hour preoperatively.

This however, does not mean that the any compromises should be made in shaping or cleaning the root canal. In keeping with this principle it is advised that the

root canal irrigants should be ejected passively into the root canal and not injected forcefully, so as to prevent their percolation into periapical tissues. If percolation takes place, it has a tendency for causing subsequent irritation of the periapical tissues.



Chapter 4

Diagnosis

Diagnosis is the process of combining results from clinical examination and tests with history, symptoms and signs of the patient to determine the cause of the disease and a treatment plan for the same.

The following are the steps that are part of a diagnostic protocol:

- History
- Clinical examination
- Diagnostic tests
- Radiographic investigations
- Diagnosis
- Treatment plan.

Diagnosis of any disease starts from the chief complaint if not from the moment the patient is seen walking into the department. Usually, the patient will provide information in his chief complaint itself that shall indicate towards the identification of irreversible pulpitis. These include:

- Throbbing pain.
- Continuous pain related to a particular tooth.
- Patient could not sleep because of toothache.
- Pain originating from a particular tooth that increases on lying down.
- Recent discoloration of a particular tooth following a history of trauma.
- Swelling with associated pus discharge.
- Trauma leading to avulsion of the tooth.

Following history taking, a visual examination is a must. The field of examination should be dry and well lit. The

region should be examined for changes in color, contour and consistency. A draining sinus would be usually located (Fig. 4.1a). This is done with the aid of a mouth mirror, explorer and/or probe. This might not be conclusive and is generally combined with certain clinical tests (Fig. 4.1b).

The clinical tests that may be performed to determine the status of the tooth include:

- *Palpation (Fig. 4.2)*: Palpation of the region using ones gloved finger might lead to the exudates of pus coming out of a sinus, which was not visible on inspection or it may elicit a painful reaction. It may also aid in determining—if the tissue is fluctuant and enlarged sufficiently to permit incision and drainage, or the

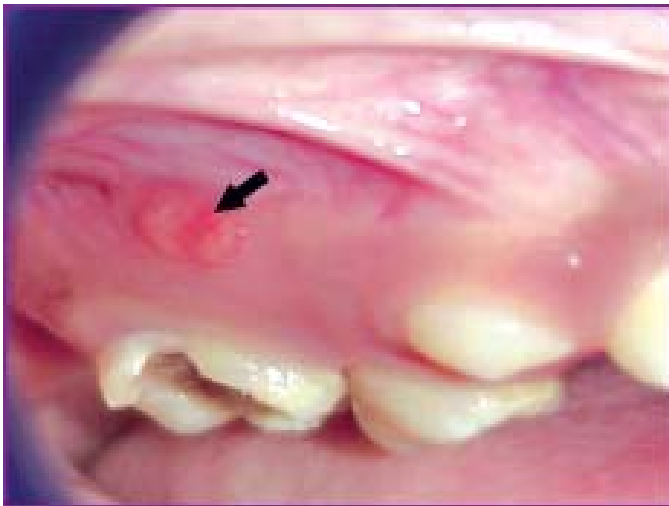


Fig. 4.1a: Visual examination might reveal a draining sinus



Fig. 4.1b: Sinus tracing done with the help of a gutta percha point



Fig. 4.2: Palpation

presence, location and intensity of pain and/or presence location and extent of adenopathy and bone crepitus. Sensitivity to finger pressure over the apex of a tooth, buccal or lingual mucosa signals further spread of inflammation to the periosteum.

- *Percussion (Fig. 4.3):* Gentle percussion along the long axis of the tooth using the blunt end of an instrument or even a gloved finger, will produce a painful response. Percussion must be performed both in the vertical and horizontal direction. Tenderness to percussion is usually associated with irreversible pulpitis.



Fig. 4.3: Percussion

- *Periodontal probing* done along the entire circumference of the teeth might lead to the discovery of pockets that could lead to pulpitis. When periodontitis occurs unrelated to periodontal conditions, it is usually as a result of pulpal necrosis.
- *Mobility and depressibility test (Fig. 4.4)* may be performed to confirm the periodontal status of a tooth. It should ideally be done using the blunt ends of two dental instruments moving the tooth laterally in its socket.

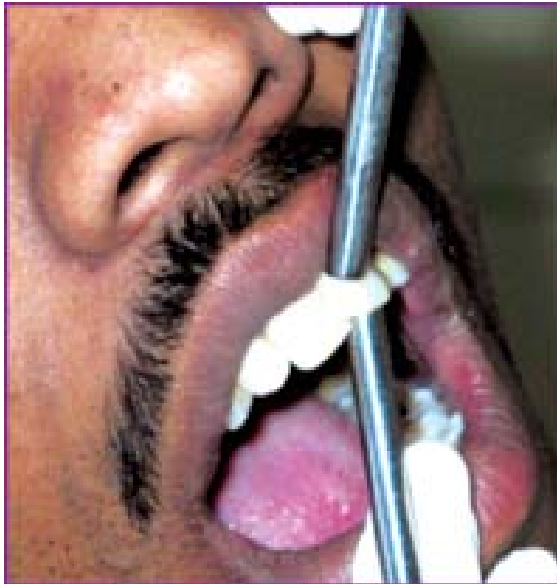


Fig. 4.4: Mobility test

The amount of movement is indicative of the periodontal status of the tooth.

The test for depressibility consists moving the tooth vertically in its socket.

- *Transillumination* (Fig. 4.5) may aid in the detection of enamel cracks or crown fractures that are otherwise not visible under the naked eye.
- *Pulp vitality tests* (Fig. 4.6 to 4.8): These test the response of the nerves to various physical, electrical or thermal stimuli (Table 4.1).
- *Radiography* (Fig. 4.9): Radiographs are the most important diagnostic tools available in the treatment of irreversible pulpitis. They provide information not



Fig. 4.5: Use of transillumination to detect enamel cracks



Fig. 4.6: Commercially-available electric pulp testers



Fig. 4.7: Thermal test-heat



Fig. 4.8: Thermal test—cold

Table 4.1: Various pulp vitality tests*Electric test:*

- Various commercially-available pulp testers.

Heat test:

- Heated instrument/solder wire.
- Heated gutta percha stick (Fig. 4.7).
- Hot water.
- Running a dry prophylaxis rubber cup.

Cold test:

- Ethyl chloride spray (Fig. 4.8).
- Stick of ice.
- Carbon dioxide crystals / dry ice.
- Freon 12.

only for diagnosis (Table 4.2) but also for prognosis, case selection, instrumentation, obturation and repair of the involved tooth and adjacent structures.

They contain vital information regarding the number, course, shape, length and width of the root canals and any other pathology present in the pulpo-periapical system.

However, radiographs provide a two-dimensional picture only and hence must be interpreted with caution.

- *Anesthetic testing:* The use of an anesthetic in diagnosis is limited to patients who are in pain at the time of presentation. It involves the selective anesthetizing of individual teeth till such time the tooth responsible for

Table 4.2: Radiographs in the diagnosis of irreversible pulpitis

- Determine the extent of caries (Fig. 4.9a). Does it involve the pulp or not?
- Presence and extent of previous restorations (Fig. 4.9b).
- Presence of fractures (Fig. 4.9c).
- Number and configuration of roots (Figs 4.9d).
- Presence of pulp stones (Fig. 4.9e).
- Increase in the periodontal ligament space (Fig. 4.9f).
- Periapical radiolucencies (Fig. 4.9g).
- Internal and /or external resorption (Fig. 4.9h).
- Periodontal space and bone height (Fig. 4.9i).

**Fig. 4.9a:** Radiograph for the determination of the extent of caries



Fig. 4.9b: Presence and extent of previous restorations

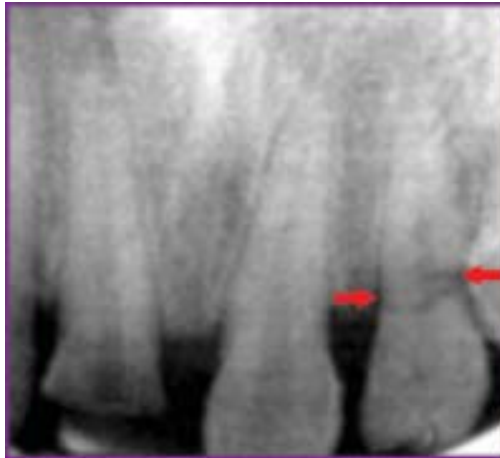


Fig. 4.9c: Presence and extent of fractures



Fig. 4.9d: Number and configuration of roots



Fig. 4.9e: Presence of pulp stones or calcified root canal



Fig. 4.9f: Increase in periodontal ligament space



Fig. 4.9g: Periapical radiolucencies

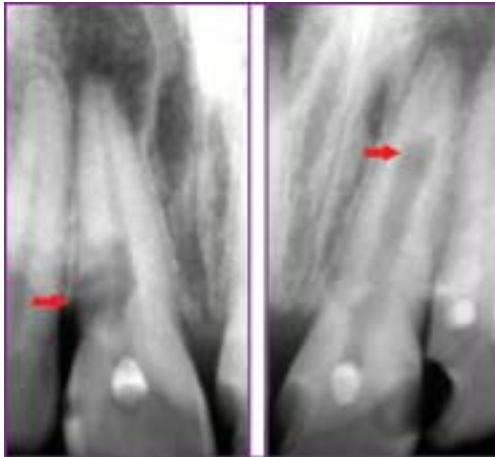


Fig. 4.9h: Presence of external and internal resorption



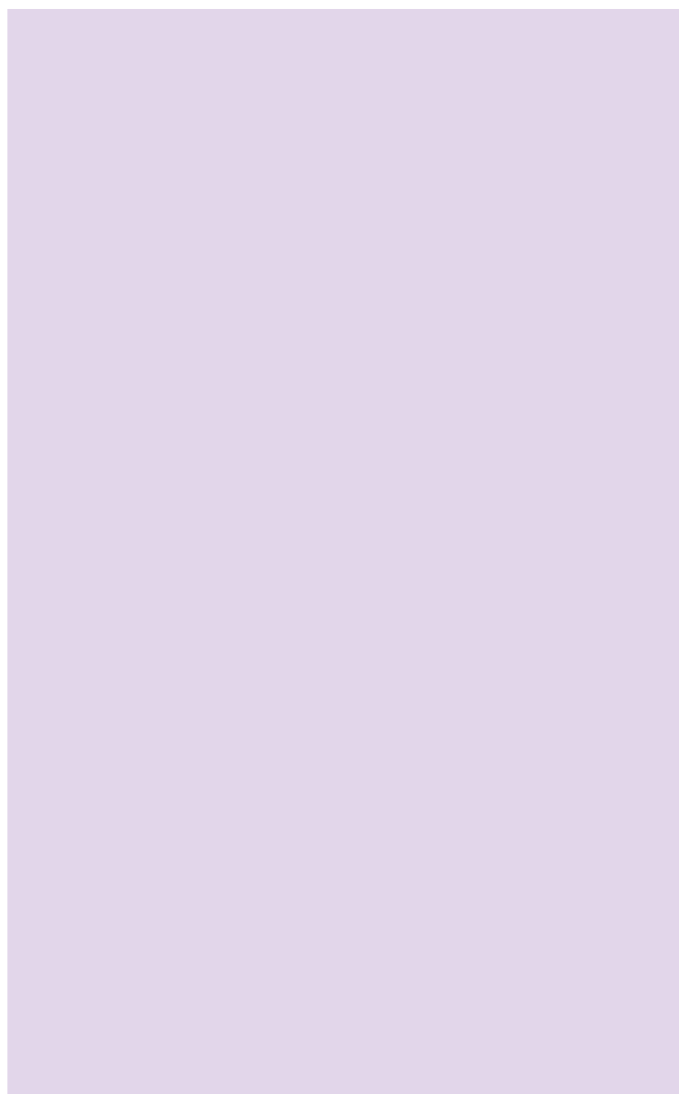
Fig. 4.9i: Estimation of periodontal support can be made by visualizing the bone height surrounding the teeth

the pain is anesthetized and the pain subsides. Infiltration and/or intraligamentary injections are used for the same.

- *Test cavity:* Used rare if ever in today's practice. Allows determining the vitality of the tooth. It involves the drilling of a tooth through the enamel-dentin junction to elicit a response from an anesthetized tooth.

Whatever the diagnosis, it is advised that the most conservative approach towards treatment should be tried first. The clinician should always work within his capabilities and avoid any unnecessary risks.

The wellbeing of the patient should be put first and no hesitation should be felt in referring the patient to a specialist if such a need arises.



Chapter 5

Access Cavity Preparation

A well-designed access cavity preparation is an inside out preparation with the basic design as that for inlay cavity. In other words it should only taper with no undercuts. It is a reflection of the interior of the tooth structure and the pulp chamber as viewed from the exterior, i.e. the incisal or occlusal surface of the tooth. From this view the entire pulp cavity along with all the canals must be visible (Figs 5.1a and b).



Fig. 5.1a: Access cavity preparation from which all canals can be visualized

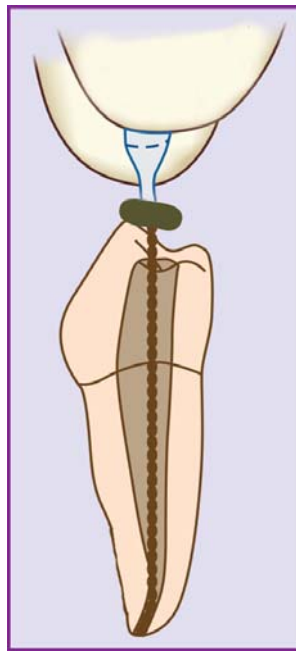


Fig. 5.1b: Straight-line pathway to the apical foramen

It is emphasized that access cavity preparation is the first step to a successful root canal treatment. The rest of the steps which follow, hinge on the accuracy and correctness of the entry, i.e. access cavity preparation.

An appropriate access cavity preparation should fulfill certain objectives (Table 5.1).

- Provide unimpeded straight-line pathway to the apical foramen and not just the canal orifices. This allows complete cleaning and shaping as well as eases quality obturation.

Table 5.1: Objectives of an ideal access cavity preparation

Straight line access

- o Improved instrument control
- o Improved obturation
- o Decreased procedural errors
- o Removal of unsupported tooth structure

Conservation of tooth structure

- o Minimal weakening of the tooth
- o Prevents accidental fracture of the tooth

Unroof pulp chamber and expose pulpal horns

- o Maximize visibility
- o Locate canals
- o Permit removal of pulpal remnants especially from the pulpal horns
- o Permit straight-line preparation

- Be parallel to the long axis of the tooth.
- Prepared though the occlusal/incisal or lingual surface of the teeth.

An improper access cavity preparation can lead to:

- Access opening that is too small can lead to:
 - o Canals being missed.
 - o Cavity walls hindering the manipulation of the root canal instrument.
 - o Tissue may be left behind in the coronal pulp, especially pulp horns. This can lead to subsequent discoloration of the tooth.
- Access cavity is too large:
 - o Indiscriminate removal of the tooth material will lead to weakening of the tooth structure.
 - o Will necessitate crown build up measures, e.g. post and core, etc.
 - o Problems of achieving a coronal seal with closed dressings.

ARMAMENTARIUM NEEDED IN ADDITION TO THE BASIC DIAGNOSTIC SET

Initial penetration into the enamel and superficial dentin is done using high-speed diamond/carbide burs (Fig. 5.2). Further penetration into deep dentine should ideally be done using medium speed diamond/carbide burs. *All burs used in access cavity preparation must be angled along the long axis of the tooth being entered.* The approximate



Fig. 5.2a: Endo access drills for air-rotor handpieces

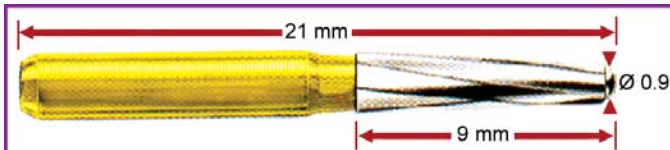


Fig. 5.2b: Safe ended burs like the Endo Z made with tungsten carbide, allow for the safe funnel-shaped preparation of the access cavity, eliminating the risk of perforation of the pulp chamber floor and/or root canal walls

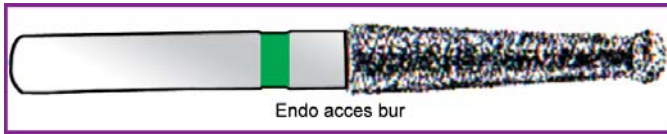


Fig. 5.2c: The bur consists of a tapering diamond tip with around cutting tip. The bur is ideally used to gain access into the pulp chamber, preparation of the cavity walls and deroofing the pulp chamber

depth of the roof of the pulp chamber may be assessed by keeping the bur against the pretreatment radiograph before beginning the access cavity preparation (Fig. 5.3).

Once a drop is felt it indicates that the pulp chamber roof has been perforated, a safe ended bur is recommended (Fig. 5.4). For lateral extensions and / or deroofing of the pulp chamber slow to medium speed large round stainless steel burs (Fig. 5.5) or safe ended diamond/carbide burs (Fig. 5.4) can be used.

Endodontic explorer, DG 16 explorer, smooth broaches, etc. can be used as pathfinders or canal locaters. When an access cavity is being prepared through a porcelain restoration or prosthesis, the use of diamond burs is recommended. Carbide or diamond burs can be used for gaining access through metal prosthesis.

ACCESS CAVITIES IN INDIVIDUAL TEETH

Maxillary Teeth

Maxillary Central Incisor (Fig. 5.6)

As the pulp is broader incisally than it is cervically, the outline of the access cavity is triangular, with its apex

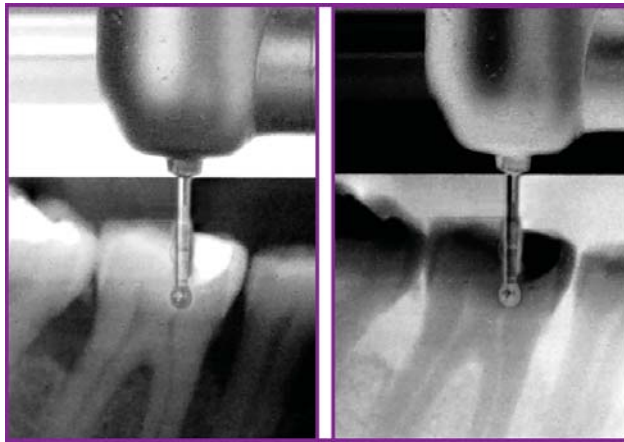
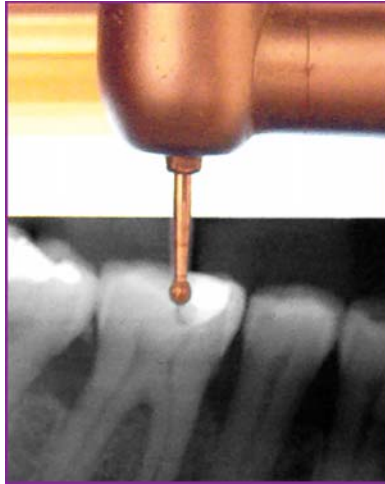


Fig. 5.3: Bur placed close to the pretreatment radiograph to estimate approximate depth of the roof of the pulp chamber or the furcation of the tooth



Fig. 5.4: Safe ended burs are recommended for deroofing the pulp chamber and the removal of any overhanging dentine to give direct access to the canals

towards the cingulum. It should extend far enough mesially and distally to include the pulp horns. The bur must be slightly distally angled keeping the angulation of these teeth in mind.

The access cavity should be close to the incisal edge so as to approach the pulp space in a straight line. This is especially true for elderly patients, where the pulp space is more difficult to find.



Fig. 5.5: Large round stainless steel burs are recommended for the penetration of deeper layers of dentine



Fig. 5.6: Different views of the access cavity preparation for maxillary central incisor

Maxillary Lateral Incisor (Fig. 5.7)

The lateral incisor is more slender than the central incisor with a canal, which is oval in cross-section. The access cavity for this tooth is also oval, with the greatest width incisogingivally. As with the central incisor the incisal extent is close to the incisal edge for direct access to the apex.

Maxillary Canine (Fig. 5.8)

The maxillary canine has narrow pulp chamber with only one pulp horn. The access cavity preparation is oval with its widest diameter incisogingivally. The access cavity is directed slightly towards the lingual surface due to the usual labial axial inclination of the crown.

Maxillary First Premolar (Fig. 5.9)

This tooth presents with the maximum number of variations in root and canal configuration. The tooth generally



Fig. 5.7: Different views of the access cavity for a maxillary lateral incisor



Fig. 5.8: Access cavity preparation for a maxillary canine



Fig. 5.9: Access cavity preparation for the maxillary first premolar

has two roots with two-root canals—buccal and palatal. The pulp chamber is wide buccopalatally with two distinct pulp horns. The access cavity preparation follows the same shape, i.e. it is oval, with its greatest width buccopalatally. The access cavity might require to be extended up to the height of the cusps because the canals usually lie beneath the individual cusps.

Maxillary Second Premolar (Fig.5.10)

The maxillary second premolar is usually single-rooted with two well-defined pulp horns. The canal is wide buccopalatally and narrow mesiodistally. The access cavity preparation is ovoid, with its greatest width buccopalatally.

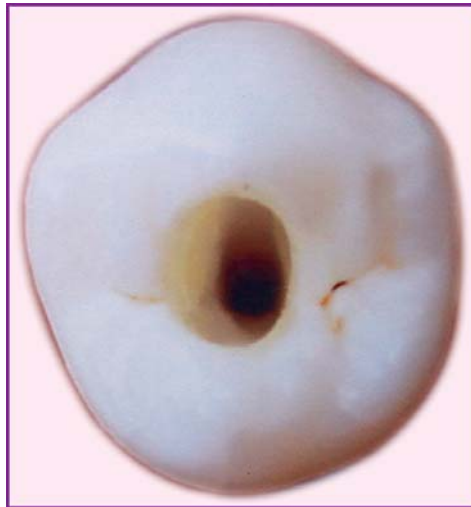


Fig. 5.10: Access cavity preparation for the maxillary second premolar

Maxillary First Molar (Fig. 5.11)

The maxillary first molar generally has three roots with three (palatal, mesio and distobuccal) or four root canals. The fourth root canal is usually located in the mesiobuccal root. The pulp chamber is quadrilateral in shape, wider buccopalatally than mesiobuccally, with four pulp horns.

The access cavity preparation is also quadrilateral in outline with rounded corners and lies on the mesial three fifths of the crown. The large palatal canal is the most easily visualized. The distobuccal canal is located 2-3 mm and palatal to the mesiobuccal canal. Mesiobuccal canal usually lies beneath the mesiobuccal canal.



Fig. 5.11: Access cavity preparation for the maxillary first molar

Maxillary Second Molar (Fig. 5.12)

The maxillary second molar is usually a smaller replica of the first permanent molar. Three separate roots with three root canals (palatal, mesio and distobuccal) may be evident. The buccal roots may be fused and present only a single root canal or two separate foramina.

The access cavity preparation may be quadrilateral in shape or triangular with the base towards the buccal and the apex palatally. It is usually located in the mesial two-thirds of the clinical crown and does not involve the oblique ridge.



Fig. 5.12: Access cavity preparation for a maxillary second molar

Maxillary Third Molar (Fig. 5.13)

The maxillary third molar displays a great deal of variability in shape and the number of roots. Three distinct roots and root canals may be present or one or more roots may be fused and the root canals may undergo the same fate or might present an even more complex configuration. Root canal treatment should be undertaken only if extremely essential and if sufficient access is present.



Fig. 5.13: Access cavity preparation for the maxillary third molar

Mandibular Teeth*Mandibular Incisors (Fig. 5.14)*

The mandibular incisor pulp chambers are practically identical and resemble smaller replicas of the maxillary



Fig. 5.14a: Different views of the access cavity preparation for the mandibular central incisor



Fig. 5.14b: Access cavity preparation for the mandibular lateral incisor

incisors. The pulp chamber has three distinct though under developed pulp horns and is pointed towards the incisal. The access cavity preparation is similar yet smaller as compared to the maxillary incisors. It is placed more incisally (to gain straight line access) and the incisal edge may be involved especially in older patients. The outline of the access cavity preparation is more oval than triangular with greatest width incisogingivally. Two canals may occasionally be present in the lateral incisor.

Mandibular Canine (Fig. 5.15)

The pulp chamber of the mandibular canine resembles that of the maxillary canine, but is proportionally smaller



Fig. 5.15: Access cavity preparation for the mandibular canine

in size, The access cavity preparation is oval with the greatest width incisogingivally. Because of the more pronounced labial curvature of the crown and the thinning out of the canal in older patients, the access cavity might involve the incisal edge of the tooth.

Mandibular Premolar (Fig. 5.16)

These teeth are usually single rooted but might show two root canals. The pulp chamber is wide buccolingually with two pulp horns. The lingual pulp horn is better developed in the second premolar and is associated with the presence of two-root canals-buccal and lingual (Fig. 5.16b). The access cavity preparation is oval with its greatest dimension buccolingually.



Fig. 5.16a: Access cavity preparation for the mandibular first premolar



Fig. 5.16b: Mandibular second premolars with two root canals

Mandibular First Molar (Fig. 5.17)

The access cavity outline resembles a trapezoid or at times a rectangle with rounded corners. The access cavity is usually located in the mesial three-quarters of the occlusal surface (Fig. 5.17a). The mandibular first molar usually has two roots with two canals in the mesial root and one canal in the distal more rounded root (Fig. 5.17b). Two canals are sometimes seen in the distal root as well (Fig. 5.17c). When present they are usually closer together because of the root morphology. The pulp chamber is wider mesially corresponding to the width of the roots.

Mandibular Second Molar (Fig. 5.18)

The mandibular second molar is a smaller version of the first molar with usually one distal canal. The usual access

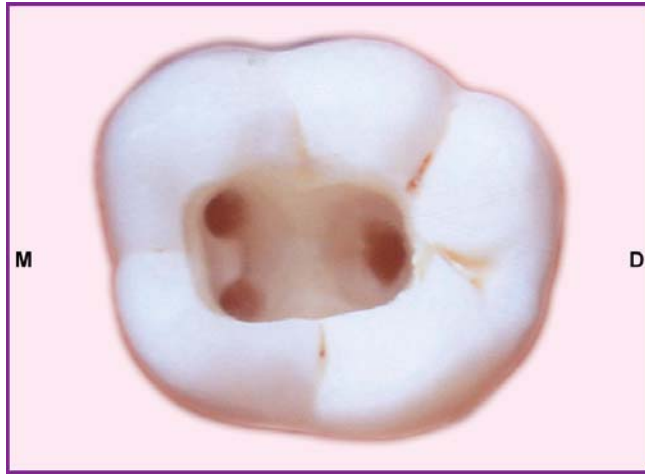


Fig. 5.17a: Access cavity preparation for the mandibular first molar



Fig. 5.17b: Mandibular first molar with two mesial and one distal canal



Fig. 5.17c: Mandibular first molar with two mesial and two distal canals



Fig. 5.18: Access cavity preparation for the mandibular second molar

cavity outline is trapezoid with rounded corners. The distal canal may present a complex morphology and usually require careful examination before actual preparation. The access cavity is usually located within the mesial two-thirds of the occlusal surface.

Mandibular Third Molar (Fig. 5.19)

The mandibular third molar shows maximum variation as respect to its form and number of roots. It generally has as many root canals as there are cusps. The mesial inclination of these teeth aids access. The outline of the access cavity is generally rectangular especially when the second distal canal is present; and is located within the mesial three-quarters of the occlusal surface.



Fig. 5.19: Access cavity preparation for the mandibular third molar

Chapter 6

Assessment of Working Length (Endometrics)

Working length can be defined as the distance from a coronal reference point to the point at which the canal preparation and obturation must end.

Once the access cavity has been prepared the next step involves the measuring the exact length of the tooth to be prepared for instrumentation. The objectives of root canal treatment cannot be achieved without knowing the exact length of the root canal. Even before that we should decide where exactly the root canal preparation should end. It is now accepted that the *root canal preparation should end at the apical constriction, the narrowest place in the canal and referred to by Kuttler in his studies as the minor constriction* (Fig. 6.1). This point lies within dentine just before the first layers of cementum begin. The advantage of using this as the termination point is that obturations made up to this point aid in the development of a solid apical dentin matrix. The root canal instrumentation and filling procedures should not extend beyond the apical foramen.

Anatomic apex—Tip or end of the root determined morphologically.

Radiographic apex—Tip or end of root determined radiographically.

Apical foramen—Main apical opening of the root canal.

Accessory foramen—Orifice on the surface of the root communicating to a lateral or accessory canal.

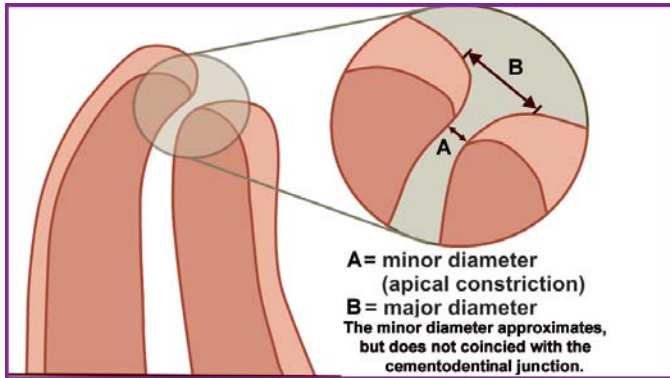


Fig. 6.1: Root canal apical third anatomy; A – Minor diameter; B – Major diameter; CDJ – Cementodentinal junction

Minor diameter (MD)—Apical portion of the root canal having narrowest diameter; usually 0.5-1 mm short of center of apical foramen (MD – where endodontics terminates).

Major diameter—Minor diameter widens to form major diameter and assumes a funnel shape (where periodontium begins).

Kuttler and Greene—In 66% (2/3rd) of the cases, apical foramen does not coincide with Radiographic apex of 2/3rd are further and 2/3rd exit buccally/lingually.

Various methods have been used for the estimation of the working length (Table 6.1). The most frequently used involve the use of radiographs or electronic apex locators.

Table 6.1: The various methods used for the estimation of the working length

1. Tactile
2. Radiographs/digital radiographs and tactile
3. Tactile + radiographs
4. Radiographs + mathematical formula
5. Electronic method
6. Paper point evaluation
7. Periodontal sensitivity

TACTILE METHOD

On its own this method should ideally never be resorted to if the facility of radiographs is available. Otherwise the point of constriction which is felt at the time of first negotiating a canal length should always be given due consideration.

An experienced clinician might detect an increase in resistance as the file approaches the apical 2 to 3 mm.

TACTILE AND RADIOGRAPHIC METHOD

The success of this method is dependant upon the quality of the radiographs (Fig. 6.2). The use of tactile sensation along with the use of radiographs was the oldest method used and has been modified over the years as our knowledge of root anatomy has improved.

The reference points for the measurement of the working length in anterior teeth are the incisal edges and for posterior teeth they are the cusp tips. Fractured incisal

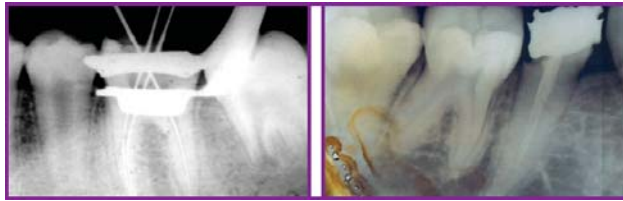


Fig. 6.2: Quality of radiographs, good quality Vs poor quality

edges or undermined cusp tips should be recontoured or ground until a sound surface is attained (Fig. 6.3).

The methods used to calculate the working length include:

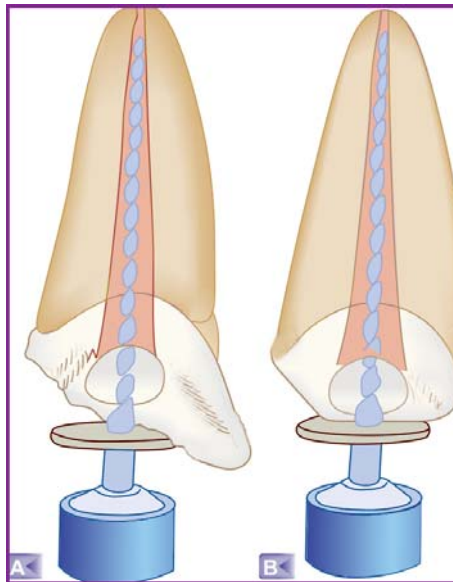


Fig. 6.3: Fractured incisal edges or undermined cusp tips should be recontoured or ground until a sound surface is attained

INGLE'S METHOD (FIG. 6.4)

The length of the tooth is measured on the diagnostic radiograph. One mm is subtracted from this measurement and transferred to a diagnostic instrument. Another radiograph is taken with this instrument in place. The distance between the tip of the instrument and end of the root canal is measured. This safety allowance must be 1 mm. The root canal is estimated from this second radiograph. The working length is 0.5 to 1 mm short of the measured canal length.

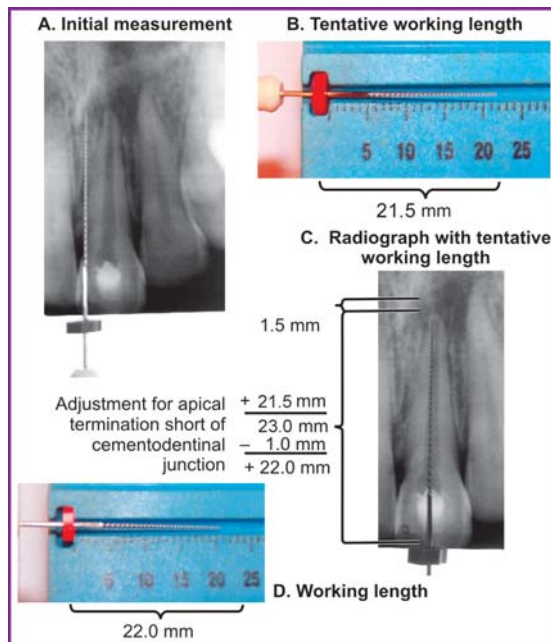


Fig. 6.4: Ingle's method

GROSSMAN'S METHOD

A premeasured file is inserted into the canal and a radiograph is taken. The radiographic length of the pretreatment teeth is taken as RLT. The length of the file is taken as RLI. The premeasured length of instrument is taken as ALI.

Thus the actual length of the teeth is determined by the formula–

$$\frac{ALT}{RLT} = \frac{ALI}{RLI}$$

$$ALT = \frac{RLT \times ALI}{RLI} = \text{--- mm}$$

It is used to calculate the length of the tooth.

The calculated length is decreased by 1 mm as a safely allowance.

WEINE'S MODIFICATION (FIG. 6.5)

After various studies Weine concluded the bone and root resorption had an effect on the actual apical tip of the infected tooth. He proposed that where ever there is radiographic evidence of either root or periapical bone resorption the following further deductions should be made in the calculated value:

No bone and root resorption = 1 mm

Either bone or root resorption = 1.5 mm

Both bone and root resorption = 2 mm

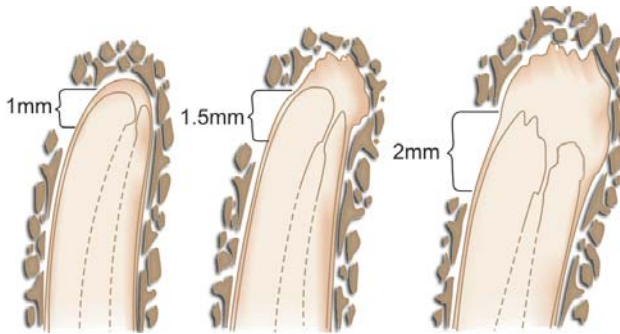


Fig. 6.5: Weine's modification taking allowance of root and/or bone resorption

Grid Technique (Fig. 6.6)

Grid technique involves the superimposition of a grid of a particular dimension over the radiograph, which is taken using the paralleling technique. The grid width assists in calculating the length of the tooth.

Advantages of radiographic technique:

- Simple.
- Not dependant on any extra-expensive equipment.
- Quite accurate.

Disadvantages of radiographic technique:

- Radiation hazard.
- Two-dimensional nature of the radiographs produces inconsistencies.
- Magnification or elongation can give inconsistent results.

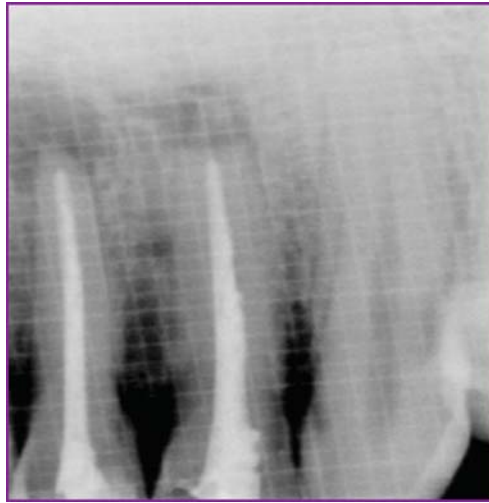


Fig. 6.6: Grid method

Electronic Method (Fig. 6.7)

The electronic method calculates the working length by comparing the electrical resistance of the periodontal membrane with that of the gingiva surrounding the tooth, both of which should be similar. The processors of these machines basically work on four mechanisms:

- Log readings.
- Subtract method.
- Taking averages.
- Taking ratios.

These mechanisms are more important as compared to the number of frequencies used to collect data, as these



Fig. 6.7: Apex locators

signify essentially how the device interprets the data. All apex locators function by using human body to complete a circuit. The apex locators are also classified based on the principle they work on.

Suzuki conducted research in 1942 and this was used by Sunada.

The apex locators are based on three principles:

- Resistance method
- Impedance method
- Frequency ratio method

Resistance Method (First Generation Apex Locators)

The electrical resistance between the mucous membrane and the periodontium registers consistent values in patients of any age and teeth of any shape and size (with a direct current = $6.5 \text{ K } \Omega$). This measures opposition to direct current.

Impedance Method (Second Generation Apex Locators)

The impedance curves for dry and wet canals have a linear relationship (i.e. they change at the same rate). Potential gradient is directly proportional to the diameter of the root canal. This value is maximum where there is maximal transparent dentin, i.e. at the apical constriction. These measure resistance to alternating current.

Frequency Ratio Method (Third Generation Apex Locators)

Low frequency oscillations (resistance sound) should be got while comparing the oral mucosa and gingival sulcus with oral mucosa and periodontal ligament.

Three electrodes are used, one each for the cheek, gingival sulcus and the root canal. When current is oscillated a memory match reading is provided.

By calculating the ratio of impedances can eliminate the influence of the type of fluid in the canal. And, detecting

the capacitance can establish a constant value, which is not influenced by conditions inside the canal and thus can be used to accurately locate the apex.

Advantages of Electronic Technique

- Only method that can measure length to apical foramen and not to the radiographic apex.
- No radiation hazards.
- Fairly accurate.
- Artificial perforations can be recognized.
- Easy and fast.
- Aids in detection of internal and external resorption.

Disadvantages of Electronic Technique

- Expensive equipment.
- Some devices may not work in the presence of pus/blood in the root canal.
- Difficult in teeth with wide open-apex.
- May give false readings in some cases which is difficult to detect.
- Contraindicated in patients with cardiac pacemakers

Chapter 7

Irrigants and Intracanal Medicaments

Effective elimination of bacteria from the root canals is achieved by instrumentation combined with irrigation. Irrigation serves as an adjunct to mechanical instrumentation. The nature and type of irrigants used play an important role in removing not only debris and necrotic tissue from the root canal but also aid asepsis, antiseptics and disinfection of the root canal system. Intracanal medicaments act as adjunct to achieving this goal.

Various irrigants have been used during root canal preparation (Table 7.1). They were usually used as antimicrobial or chelating purposes, but their functions now far

Table 7.1: The various irrigants used in root canal treatment
(Courtesy: Dr Premanand Kamath)

Antimicrobial

Sodium hypochlorite
Hydrogen peroxide
Chlorhexidine
MTAD
Iodine
Metronidazole
Tublicid

Chelating

EDTA 17%
REDTA
EDTAC-Rc Prep
Salvizol

Combination

NaOCl + EDTA
NaOCl + Chlorhex
Laser with Irrigants, Diode / Nd: YAG
NaOCl + Surfactants
NaOCl + Over-proof alcohol

exceed their initial intended use (Table 7.2). Presently, the most-commonly used irrigant is sodium hypochlorite (NaOCl). Chlorhexidine, EDTA and normal saline are also routinely used for the purpose.

Sodium Hypochlorite (NaOCl) (Fig. 7.1a)

- Most-widely used and recommended irrigant used in endodontics.
- Used in concentrations varying from 1 to 5%. The 5% concentration is dilute enough to be effective yet only a mild irritant to the periapical tissues.
- It is a powerful irrigant with tissue solvent properties (Fig. 7.1b).
- It is also an effective antimicrobial.
- In combination with EDTA it releases nascent oxygen (Fig. 7.1c).
- It can be conveniently prepared by diluting household liquid bleach (5.25% NaOCl).



Fig. 7.1a: NaOCl irrigant



Fig. 7.1b: Irrigation with NaOCl

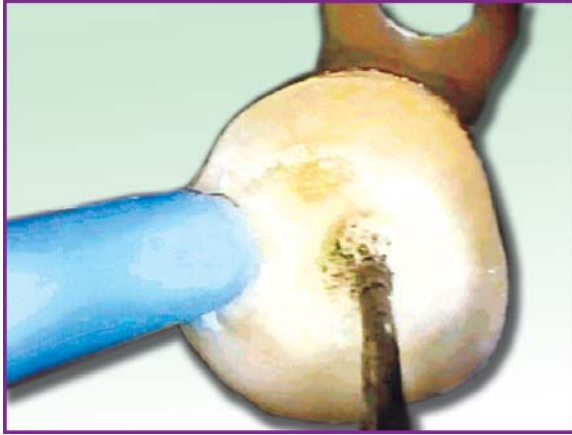


Fig. 7.1c: Effer vescence action of NaCOI and EDTA

- However, it can cause toxic reactions if it comes in contact with vital tissues and hence cannot be used at full strength.

Chlorhexidine (CHX) (Fig. 7.2)

- 2% is recommended for endodontic use
- Broad spectrum antimicrobial activity
- Substantivity
- Relative absence of toxicity
- Inability to dissolve necrotic pulp
- Can be used in patients with NaOCl allergy
- Effective against *E. faecalis*.

Ethylenediaminetetraacetic Acid (EDTA) (Fig. 7.3)

- Effective chelating agent.



Fig. 7.2: Chlorhexidine

Table 7.2: Functions of an irrigant

- To irrigate the canal system. Dentine shavings tend to float to the pulp chamber from where they can be aspirated with suction.
 - To lubricate the canal walls decreasing fracture of the inserted instruments.
 - Antibacterial and germicidal.
 - Antisepsis and disinfection.
 - Necrotic tissue solvents.
 - Effective in smear layer removal.
-
- Effective for removal of the smear layer before canal obturation.
 - Might be useful in the location of difficult to locate canal orifices.



Fig. 7.3: Commercially available EDTA preparation

- Can be carried in paste form on a instrument into the canal.
- *Reacts with glass, so should not be brought in contact with glass syringes or glass slabs.*
- *Overzealous use can lead to perforations or formation of false canals.*
- Are useful as irrigants in calcified canals

RC Prep (Fig. 7.4)

- Combines the function of EDTA and urea peroxide.
- Has a both chelating and irrigational action.
- The foamy solution has natural effervescence that is increased by irrigating with NaOCl.

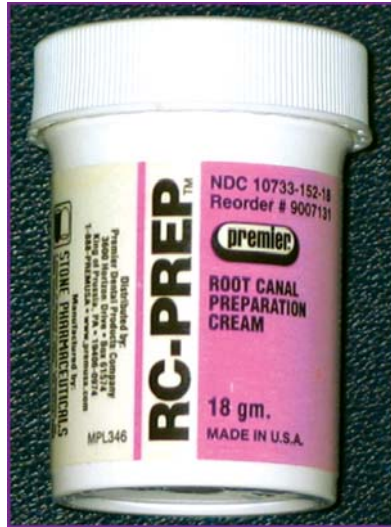


Fig. 7.4: RC Prep

METHOD OF IRRIGATION

The irrigants are carried into the canal in disposable plastic syringes of 2 to 5 ml capacities. The needles of such syringes may be bent at 30 to 60 degrees to provide direct access to the canal orifices. The needles may have vents that are either at the end, beveled or present on the sides of the needle (Fig. 7.5a). The irrigant should be ejected gently into the canal and not injected forcefully. Commercially available syringes and needles are available (Fig. 7.5b).

Needles with vents in the sides are better as they do not force the solution into the periapex (Fig. 7.5c).

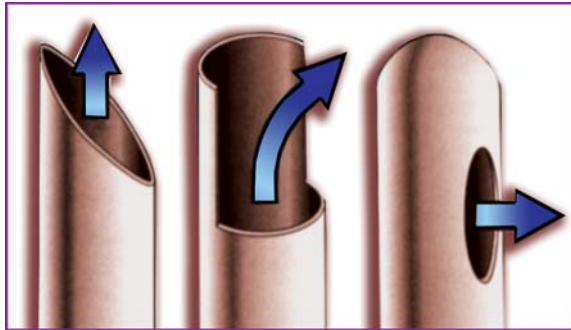


Fig. 7.5a: Various configuration of needles available for irrigant delivery



Fig. 7.5b: Commercially available needle configurations for irrigant delivery

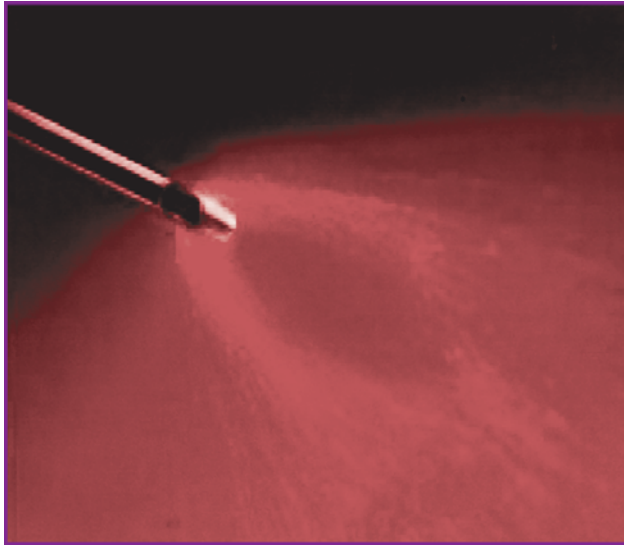


Fig. 7.5c: Irrigant spray through the side vented needle is better

Intracanal Medicaments

Intracanal medicaments were primarily used for their antimicrobial activity. The drugs used were generally caustics (phenols) that adversely affected the periapical tissues. The scope of intracanal medicaments has increased tremendously (Table 7.3). The most commonly used intracanal medicament used nowadays is calcium hydroxide.

Calcium Hydroxide (Figs 7.6a to c)

- Calcium hydroxide can be used in aqueous, viscous or oily suspension / paste.

Table 7.3: Scope of intracanal medicaments

- Antimicrobial activity.
 - Antisepsis.
 - Disinfection.
 - Hard tissue formation.
 - Anti-inflammatory.
 - Pain control.
 - Exudation control.
-
- It is a potent antibacterial.
 - Because of its high pH it possesses a cauterizing function (burns residual chronic inflamed tissue).
 - In paste consistency it physically restricts bacterial colonization.

**Fig. 7.6a:** Commercially available forms of calcium hydroxide



Fig. 7.6b: Commercially available forms of calcium hydroxide

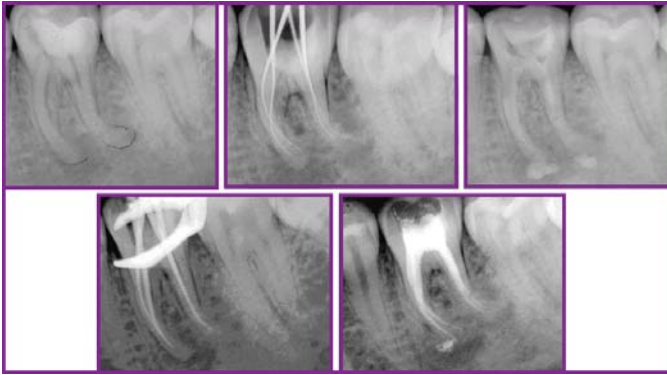


Fig. 7.6c: Case treated in conjunction of calcium hydroxide intracanal medicament

- The calcifying potential of the chemical can aid in build up of bone in the resorption sights of perforations.
- Other additives may be added for antibacterial effect; these include–iodine, chlorphenols, chlorhexidine, etc.

Chapter 8

Biomechanical Preparation

RULES GOVERNING BIOMECHANICAL PREPARATION

1. Direct access should be obtained along straight lines.
2. Smooth instruments should precede rough instruments.
3. The length of the tooth should be accurately determined.
4. Instruments should be used in sequence of sizes.
5. Reamers to be given $\frac{1}{4}$ to $\frac{1}{2}$ turn.
6. Files to be used with pull motion.
7. Reamers and files to be used with instrument stops.
8. The canals should be enlarged at least three sizes greater than its original diameter.
9. A reamer or a file should not be forced if it binds into the canal.
10. All instrumentation should be done in a wet canal.

INSTRUMENT STANDARDIZATION

According to this:

- The files were assigned numbers from 6 to 140 based on diameter of the tip of the instrument in hundredths of a millimeter (Fig. 8.1).
- The blade extends up the shaft for a length of 16 mm.
- The angle of the tip ranges from $75^{\circ} \pm 15^{\circ}$.

Classification

Group I: hand use only, e.g. files both k type and h type.

Group II: engine driven (same design as group I).

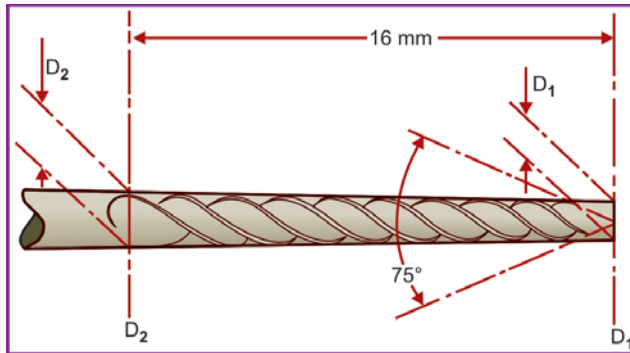


Fig. 8.1: Standardized dimensions of root canal files and reamers established by the ISO. Specification for shapes of the tip: 75 degrees, ± 15 degrees. The taper of the spiral section must be at a 0.02 mm gain for each millimeter of cutting length

Group III: engine driven latch type, e.g. drills or reamers like Gates Glidden.

Group IV: root canal points.

At present instruments with taper greater than 0.02 have become popular: 0.04, 0.06, 0.08. These are the greater taper instruments.

CONVENTIONAL METHOD OF BIOMECHANICAL PREPARATION

1. Access opening is made.
2. Length of the tooth is accurately determined.
3. Reamer of suitable size is selected.
4. Extirpation of pulp tissue from the root canal.
5. Enlarging the canal with a reaming motion: insertion-rotation-retraction.

6. Irrigation of the canal.
7. Canal is enlarged to the adequate size.
8. Recapitulation: advance –retreat, to maintain patency of the canal to avoid ledge formation and to prevent apical blockage.

TECHNIQUES FOR CLEANING AND SHAPING

1. Step back method
2. Step down method
3. Hybrid method
4. Balanced force technique

Step Back Technique (Figs 8.2a and b)

- First described by Weine, Martin, Walton, and Mullany. also called “*Telescopic*” or Serial Root canal preparation.”

Divided into:

Phase I – Apical preparation starting at constriction.

Phase II – Preparation of the remainder of the canal, gradually stepping back while increasing the size of the instrument.

Refining Phase II A and IIB – Completion of preparation to produce taper from apex to cervical.

Phase I

1. Establish working length after gross debridement – apical constriction should be identified.

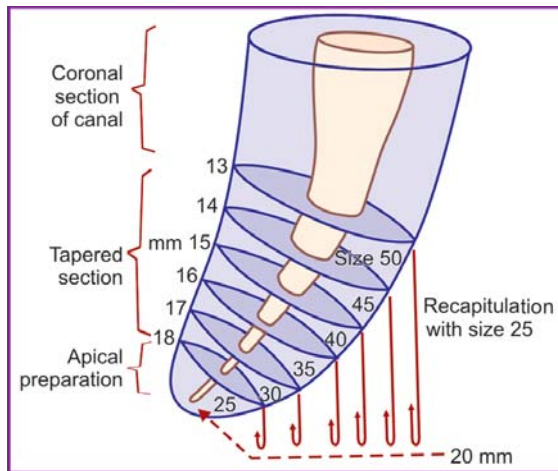


Fig. 8.2a: Step-back technique

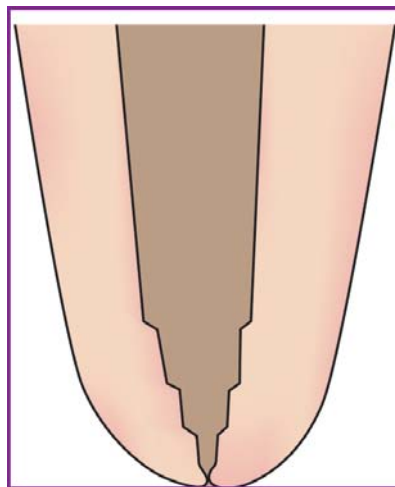


Fig. 8.2b: Canal configuration in the step-back technique

2. 1st instrument – No. 08, 10, 15....
3. Motion is “Watch Winding”, i.e. two or three quarter turns clockwise, counter clockwise and then retraction. Procedure repeated till instrument loose in position.
4. By the time size 25 k is used to full working length Phase I is complete (Apical 1-2 mm).
5. Irrigation with sodium hypochlorite and recapitulation after each step.

Phase II

1. Begins with no. 30 k file – Working length 1mm short of full working length. Repeat same as above till instrument is loose.
2. Recapitulation.
3. Next instrument no. 35, shortened by 1 mm from previous file, i.e. 2 mm from apex.
4. Recapitulation and irrigation.
5. Thus preparation steps back into the canal 1 mm with one larger instrument.
6. When mid canal is reached, perimeter filing is started.
7. For mid-canal – H files or Gates Glidden Drills are usually used.

Refining Phase

Return to size no. 25, smoothening all around with vertical push – pull stroke. At this stage, sodium hypochlorite 5.2% should be used for 5 to 10 min.

Final preparation should be an exact replica of the original canal configuration, shape, taper, flow but only larger in size.

- “Coke – bottle” prep.
 - In case of curved canals – pre-curve the files.
- Calcified canals – EDTA preparations may be used.

Step Down Technique (Figs 8.3a and b)

- Marshall and Pappin first advocated “**Crown – Down Pressure less Technique**”.
- Primary purpose was to minimize or eliminate the amount of necrotic debris that could be extruded beyond foramen. Also, freedom from constraint of apical enlarging instrument.

Steps

- i. Access cavity filled with NaOCl 5.2%, 1st instrument introduced into the canal.
- ii. Patency of the canal till the apical constriction.

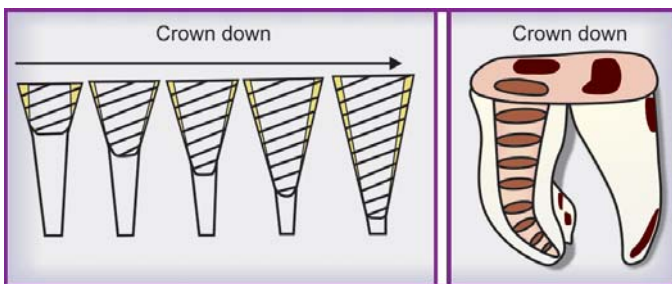


Fig. 8.3a: Crown down technique

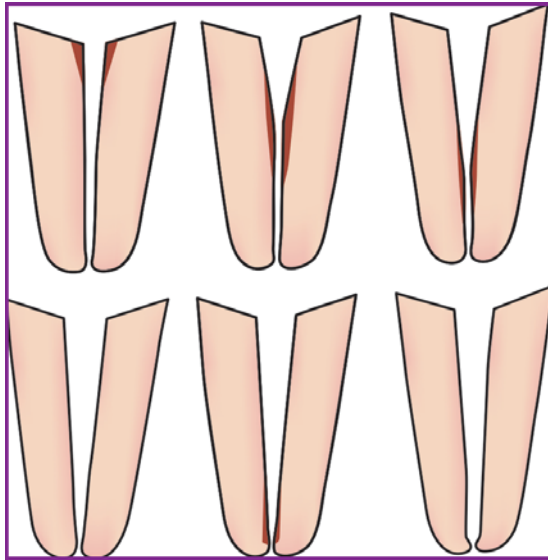


Fig. 8.3b: Step by step canal configuration in the crown down technique

- iii. Enlarge coronal 1/3rd with Gates Glidden drill.
- iv. Preparation starts from higher to lower, e.g. Start with No. 50 file going down to No. 15, until apical constriction is reached. When resistance is met, next smaller size is used.
- v. Irrigation and recapitulation at each step.

Balanced Force Technique (Fig. 8.4)

- Using Flex-R_files

Principle: Positioning and pre-loading an instrument through a clockwise rotation 270 then shaping the canal with a counter clockwise rotation of 90°.

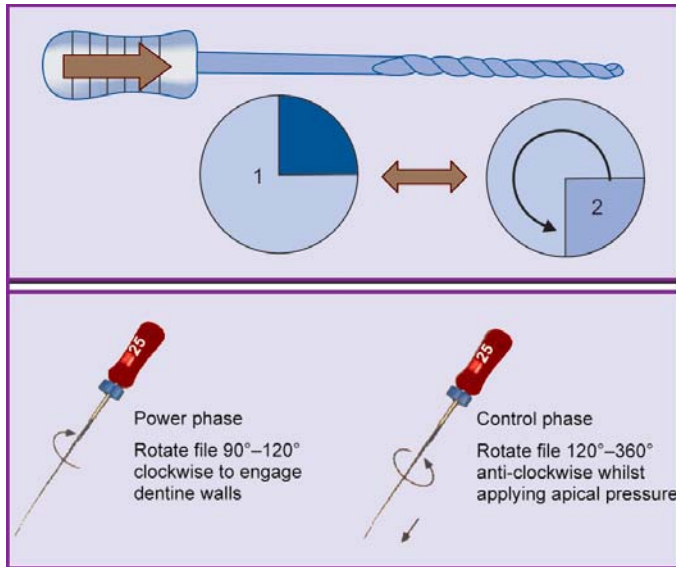


Fig. 8.4: Balanced force technique

Advantages of Step Back Technique

- i. Less likely to cause periapical trauma.
- ii. Facilitates removal of more debris.
- iii. Greater flare.
- iv. Development of apical matrix or stop prevents overfilling.
- v. Greater condensation pressure can be exerted which fills the lateral canals.
- vi. Can preserve root structure, relocate canal away from furcal danger.

Advantage of Step Down Techniques

Over instrumentation beyond the anatomic apex has the potential of causing:

1. Direct physical trauma to the periapical tissue.
2. Induce the necrotic canal contents including dead and living microorganisms to be pushed into the periapical region leading to persisting infection.
3. Bleeding into the root canal, which may provide nutrition to the intracanal bacteria.
4. Increase in the foramen size leading to a greater possibility for the microorganisms to get nutrients from the periapical region.
5. It increases the risk of extrusion of irrigating solutions as well as the obturating material beyond the periapex.
6. There always exists the possibility of creating an oval foramen instead of a round one, which is especially true for curved canals. This in turn might lead to a poor apical seal as the master cone of gutta percha has a round tip; also, the narrow area might generate a hideout for residual microbes.

GREATER TAPER INSTRUMENTS

(Figs 8.5a and b)

In the greater taper instruments for every millimeter gain in the length of the cutting blade the width of the instrument increases by 0.04, 0.06 and 0.08 of a millimeter.

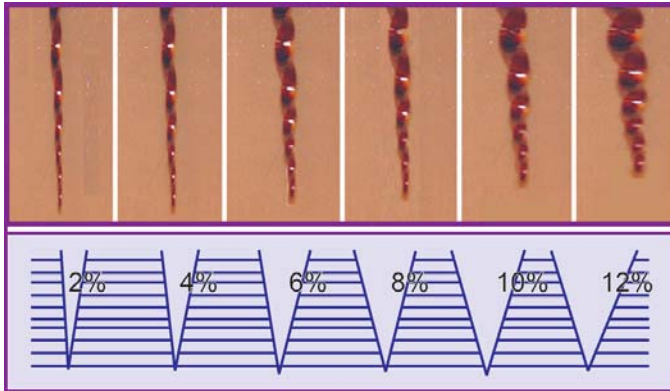


Fig. 8.5a: Greater taper instruments have greater degree of taper



Fig. 8.5b: Hand GT files are a classic example of greater taper instruments (*Courtesy: Dr Chirag Sarkari*)

NICKEL TITANIUM INSTRUMENTS

(Figs 8.6a to e)

With the advent of nickel titanium instruments, the field of endodontic dentistry has undergone a sea change.

The two properties of Ni Ti that make it so useful are

1. Superelasticity
2. Shape memory

These properties make Ni Ti files more flexible, better conforming to canal anatomy, resist fracture and wear less than stainless steel files.

Nickel titanium files should always be used with a rotational or reaming motion.

PRECAUTIONS TO BE TAKEN WHEN USING NICKEL-TITANIUM

1. Never force a file.
2. Curved canal that have a high degree and small radius of curvature.



Fig. 8.6a: Protaper NiTi instruments

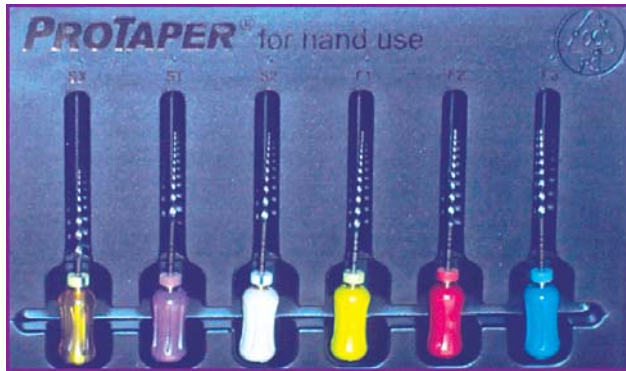


Fig. 8.6b: Hand protaper NiTi instruments

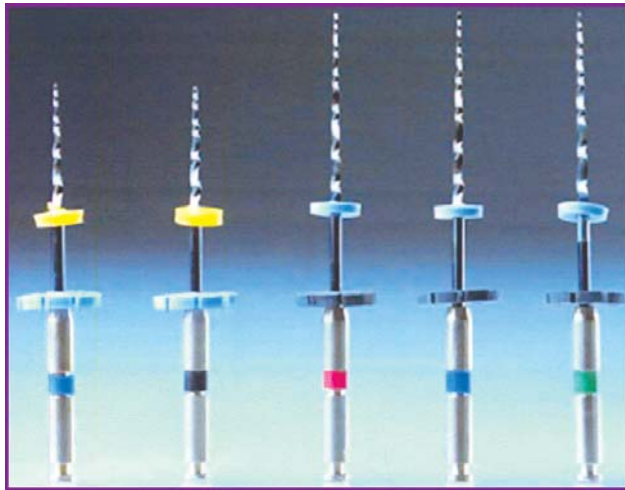


Fig. 8.6c: FKG RaCe NiTi instruments



Fig. 8.6d: Quantec series of NiTi instruments



Fig. 8.6e: Light speed NiTi instruments

3. Never overuse the file.
4. A nickel titanium instrument should not be used to bypass a ledge.
5. Teeth with s-shaped canals should be approached cautiously.
6. Do not apply extra-pressure if the instruments hits bottom after progressing easily.
7. Avoid cutting with the entire length of the blade.
8. Sudden changes in direction must be avoided.
9. Periodic inspection of used instruments is critical.

ROTARY INSTRUMENTATION

Gates Glidden Drill (Fig. 8.7) and Peeso-Reamers (Fig. 8.8)

Both Gates Glidden drill and Peeso Reamer are slow speed instruments. They come in sizes 1-6 and are being converted to ISO standardization. The size is denoted by the number of rings in the shaft of the instruments. These are latch type devices that can be attached to the micro-motor slow speed hand piece and are to be run at speed of approximately 800 to 1000 rpm. These



Fig. 8.7: Gates Glidden drills

are lateral cutting instruments with a safe ended tip. These are stainless steel instruments. These instruments generally break between the shaft and the shank junction. In such accidents they can be easily retrieved with the help of a hemostat or a locking pliers.

Gates Glidden drill (Fig. 8.7) are football shaped, less aggressive instruments and therefore can be used deeper in the canal.

Peeso Reamers are parallel sided straight and more aggressive instruments (Fig. 8.8).

These are to be used strictly in the coronal 1/3rd of the canal to remove dentin bulges. In addition they can also be used to prepare post and core spaces, and removal of gutta percha in retreatment cases.



Fig. 8.8: Peeso Reamers

Chapter 9

Sealers and Obturating Materials

ROOT CANAL SEALERS

When we have taken so much pain to prepare a canal to its exact working length and to a predetermined shape then the question arises—why do we need a sealer? Well, it should be remembered that the canal configuration is extremely complex and it is usually not completely visible on the two-dimensional radiograph.

Hence, we can never be sure of the presence of accessory canals as well as the true shape of the canal. It is here that the role of a root canal sealer comes into play. The sealer, as the name suggests, primarily, seals the discrepancies between the canal walls and the core obturating material, besides other functions (Table 9.1). It should always be used in conjunction with an obturating material and by itself has very limited effectiveness. Various requirements have been advocated for an ideal root canal sealer (Table 9.2) but the basic remain its *sealing capability*, *insolubility in the root canal environment* and *non-irritating to the periapical tissues*. Some of the commonly used cements include:

Zinc Oxide-Based Cements

Zinc Oxide Eugenol:

- Developed by, Rickert' (Kerr Pulp canal sealer, Kerr Dental, etc).
- Meet all the ideal requirements of sealers as proposed by Grossman except for *severe staining*. The silver, added for radiopacity causes discoloration of the teeth.

Table 9.1: Functions of a root canal sealer

- Sealing the discrepancies between the canal walls and the core obturating material.
- Cementing the core obturating material in the root canal.
- Acts as a lubricant for the seating of the obturating material.
- Acts as a bactericidal agent.
- Acts as a marker for accessory canals, resorptive defects etc. that the core obturating material may not penetrate.

Table 9.2: Ideal requirements of a root canal sealer

1. It should be tacky when mixed, to be able to provide good adhesion / sealing between the canal walls and the core obturating material.
2. Flowability in its non-set state to promote luting.
3. It should be non-irritating to the periapical tissues.
4. Should possess a hermetic sealing ability.
5. It should be radiopaque.
6. Minimal setting shrinkage.
7. Should be non-staining on the dentine / tooth structure.
8. It should be ideally bactericidal (or at least not encourage bacterial growth).
9. Should have a reasonably long working time.
10. Insoluble in tissue fluids.
11. It should be easy to remove if necessary.
12. It should be neither mutagenic nor carcinogenic.
13. It should not provoke an immune reaction

- In 1958, Grossman recommended a *non-staining* ZOE cement (Table 9.3) as a substitute for Rickert's formula. Commercially, it is available as Roth Sealer (Roth, Chicago, IL, USA), Roth's 801 or Pulp Canal Sealer (Kerr), etc.

Table 9.3: Composition of Grossman's sealer

Powder		
	Zinc oxide reagent	42 parts
	Staybelite resin	27 parts
	Bismuth Subcarbonaic	15 parts
	Barium Sulfate	15 parts
	Sodium Borats, anhydrons	01 part
Liquid		
	Eugenol	

Advantages

1. Plasticity
2. Long setting time
3. Good healing capabilities

Disadvantages

1. Decomposition by water occurs over a period of time

Tubliseal (Kerr, Romulus, MI, USA)

- Marketed as *two-paste* system.
- The base paste also contains barium sulfate as a radiopacifier as well as mineral oil, cornstarch and lecithin.

- The catalyst paste—polypale resin, eugenol and thymol iodide.
- It had the disadvantage of a *rapid set*, especially in the presence of moisture.
- Advantage—ease of preparation.

Wach's Cement

- *Powder base:* ZnO, bismuth subnitrate and bismuth subiodide as radiopacifiers, as well as magnesium oxide and calcium phosphate.
- *Liquid:* Oil of clove along with eucalyptol, Canada Balsam and Beechwood Creosote.
- It has an advantage as the mix is of a very smooth consistency.
- The only disadvantage of this cement is the unpleasant odor of liquid.

Medicated variations of ZOE cements include:

(i) N2 (ii) RC 28 (iii) Spad (iv) Endomethasone

Nogenol

- *Base:* ZnO, barium sulfate as the radiopacifier along with a vegetable oil.
 - *Catalyst:* Hydrogenated rosin, methyl obietate, lauric acid, chlorothymol and salicylic acid.
- Adv:* Removal of eugenol helps in reducing toxicity.

Calcium Hydroxide-Based Cements as Sealers

Calcium hydroxide sealers were developed with the assumption that:

- They preserve the vitality of the pulp stump, and
- Stimulate healing and hard tissue formation at the apex.

CRCS (Calcibiotic Root Canal Sealer)

- ZOE/Eucalyptol sealer to which $\text{Ca}(\text{OH})_2$ has been added for its osteogenic effect.
- Takes 3 days to set fully in either dry or humid environments.
- Quite stable and has certain amount of osteogenic effect.

Sealapex (Kerr)

- *Base*: ZnO with $\text{Ca}(\text{OH})_2$ as well as butyl benzene, sulfonamide, and Zn Stearate.
- *Catalyst*: Barium sulfate and titanium dioxide as radiopacifiers as well as proprietary resin, isobutyl salicylate and aerocil.

Life

- $\text{Ca}(\text{OH})_2$ liner and pulp—capping material; similar in formulation to seal apex, has also been suggested as sealer.

Apexit (Ivoclar-Vivadent, Lichtenstein)

Vitapex

- $\text{Ca}(\text{OH})_2$ sealer that contains 40% Iodoform and Silicone oil, as the other component.

MCS (Medicated Canal Sealer)

PLASTICS AND RESINS (Fig. 9.1)

Diaket

Resin—reinforced chelate formed between ZnO and a small amount of plastic dissolved in the liquid B-diketone.



Fig. 9.1: Few commercially available resin sealers

AH-26 (Dentsply, Konstanz, Germany)

- Epoxy resin is very different as compared to zinc oxide-eugenol and calcium hydroxide sealers. It is a form of glue.
- *Base*: Biphenol A-epoxy.
- *Catalyst*: Hexamethylene-tetramine.
- Also contains 60% Bismuth oxide for radiographic contrast.
- It sets slowly in 24 to 36 hours.
- It had good sealing / adhesive properties.
- Strong antibacterial properties gave it an initial severe inflammatory reaction.
- The resin had a strong allergenic and mutagenic potential.

Also sold as ***Thermaseal***.

AH-Plus (Dentsply, Konstanz, Germany)

- Improved version of AH-26 Epoxy resin “glue” retained, but new Amines are added.
- Working time – 4 hours.
- Setting time – 8 hours.

Also sold as ***thermaseal plus***

NEWER MATERIALS

1. Glass-Ionomer cements have also been developed for Endodontics – One of these is KETAC-ENDO.
2. Pit and fissure sealants.
3. Dentin bonding agents (Gluma).

MATERIALS USED IN OBTURATION

Grossman delineated 11 requirements for an ideal root canal filling material:

1. It should be easily introduced into a root canal.
2. It should seal the canal laterally as well as apically.
3. It should not shrink after being inserted.
4. It should be impervious to moisture.
5. It should be bacteriostatic or at least not encourage bacterial growth. It should not stain tooth structure.
6. It should not irritate periradicular tissue.
7. It should be sterile or easily and quickly sterilized immediately before insertion.
8. It should be easily removable from the root canal, if necessary.
9. It should not stain the tooth.
10. It should be radiopaque.
11. The powder must be very fine so that it mixes easily with the liquid.

Two more properties that can be added are:

12. It should be non-carcinogenic and non-mutagenic.
13. It should not provoke an immune reaction.

Grossman also grouped acceptable filling materials into:

Plastics, solids, cements and pastes.

SOLID-CORE MATERIALS

Gutta percha is by far the most universally used solid-core root canal filling material and may be classified as Plastic.

GUTTA PERCHA (Figs 9.2a and b)

- Introduced by “Bowman” in 1867.
- Fulfills requirements of ideal filling material.



Fig. 9.2a: Standardized gutta percha points



Fig. 9.2b: Non-standardized gutta percha points

- True gutta percha may not be supplied in dental profession.
- Manufacturers admit they have used “Balata” which is dried juice of *Brazilian trees* “*Manilkara bidentata* of sapodilla family.

Gutta percha also comes from *sapodilla family*, but from *Malaysian trees*, genera *Payena* or *Palaquim*.

Both are chemically-identical.

Chemically, pure Gutta percha (or Balata) exists in *two different crystalline forms—Alpha and Beta*.

The beta form is more commonly used in dentistry

Configuration: It is of 2 types.

- a. *Conventional or non-standardized—used as auxillary-cones.*
- b. *Standardized.*

They approximate the diameter and taper of root canal instruments (ISO). Available in standards – 0.02 as well as increased taper sizes of 0.04, 0.06, 0.07, 0.08, 0.09.

Also, expressed as 2%, 4%, 6%, 7%, 8% and 9%.

Used as primary cone.

COMPOSITION

Friedman et al reported several exhaustive studies on the physical properties of gutta percha as used in the endodontic procedures.

The composition of commercially available gutta percha cones is:

<i>Material</i>	<i>Percentage</i>	<i>Function</i>
i. Gutta percha	18-22%	Matrix
ii. Zinc oxide	59-76%	Filler
iii. Waxes or Resins	1-4%	Plasticizer
iv. Heavy metal sulphates	1-18%	Radiopacifier

SOLVENTS OF GUTTA PERCHA (Fig. 9.3)

- i. Eucalyptol
- ii. Rectified white turpentine
- iii. Chloroform
- iv. Xylol
- v. Ether
- vi. Orange oil extracts
- vii. Halothane
- viii. Methyl chloroformate
- ix. Benzol



Fig. 9.3: Few commercially available gutta percha solvents

Chapter 10

Obturation of the Radicular Space

OBJECTIVES

1. Substitution of an inert filling in the space previously occupied by the pulp tissue, to prevent recurrent infection by way of circulation (anachoresis) or through break in integrity of crown of tooth.
2. Development of fluid-tight seal at apical foramen.
3. Total obliteration of root canal.
4. Coronal seal.

Extension of the Root Canal Filling

- Anatomic limits of the pulp space—Dentino-cemental junction (DCJ) apically and pulp chamber coronally.
- DCJ is an average of 0.5 to 0.7mm from the external surface of apical foramen, and is major factor in limiting filling material to the canal.

Terms to be Understood

- i. *Overfilling* (Fig. 10.1a): “Total obturation” of the root canal space with excess material extruding beyond apical foramen.
- ii. *Over-extension* (Fig. 10.1b): May denote extrusion of filling material beyond apical foramen but canal may not be adequately filled and apex may not be sealed.
- iii. *Underfilling*: It is a 3-dimensional (Fig. 10.1c) partial/semi/incomplete obliteration of the root canal with apical area of root canal space left unfilled.

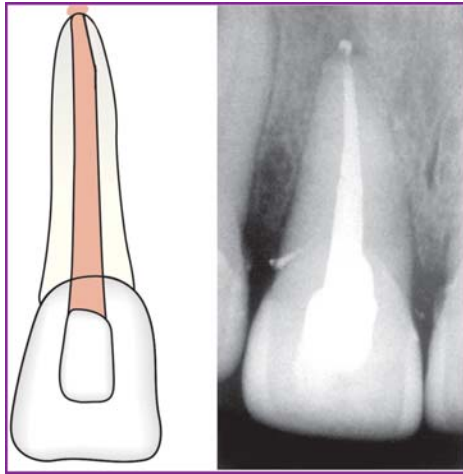


Fig. 10.1a: Overfilling

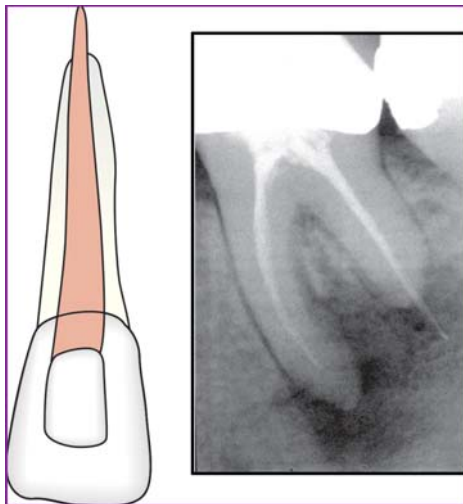


Fig. 10.1b: Over-extension

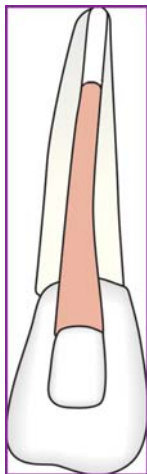


Fig. 10.1c: Underfilling

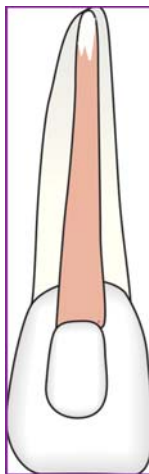


Fig. 10.1d: Under extension



Fig. 10.2: Radiographic “Puff”

- iv. *Under extension:* Filling material short (Fig. 10.1d) of apex with loosely filled canal and apical area of root canal left unfilled.

Most of the dentists prefer to fill to the radiographic external surface of the root or just beyond. They seek to develop a small “puff” or “button” of overfilling (Figs 10.1a and 10.2).

When to Obturate?

- When canal is cleaned and shaped to an optimum size and dryness.
- Tooth is asymptomatic (i.e. no signs of active periapical pathology).
- No draining sinus.
- No foul odour from canals.

Reduction in the number of microorganisms by canal preparation and medication.

METHODS OF OBTURATING THE ROOT CANAL SPACE

The methods are listed as follows:

Solid—Core Gutta Percha with Sealants

A. Cold Gutta Percha Points (Fig. 10.3)

- i. Lateral compaction.
- ii. Variations of lateral compaction

B. Chemically-Plasticized Cold Gutta Percha

- i. Essential oils and solvents:
 - a. Eucalyptol
 - b. Chloroform
 - c. Halothane

Newer Methods (Figs 10.4a to h)**C. Canal-warmed Gutta Percha**

- i. Vertical compaction
- ii. System B compaction
- iii. Sectional compaction
- iv. Lateral/vertical compaction:
 - a. Endotec II
- v. Thermomechanical compaction:
 - a. Microseal system, TLC, Engine – Plugger, and Maillefer condenser

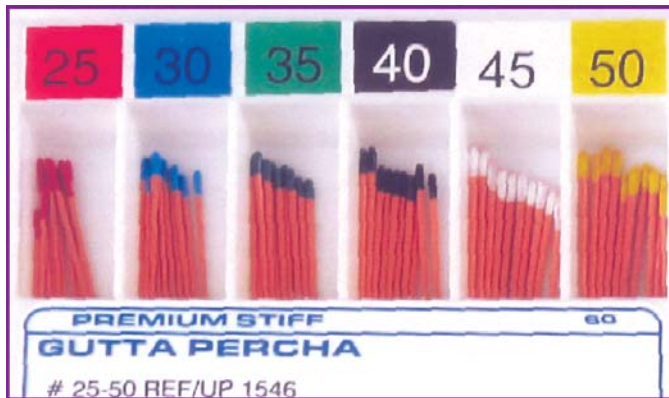


Fig. 10.3: Commercially available gutta percha points



Fig. 10.4a: Canal warmed gutta percha-Successfil



Fig. 10.4b: Canal warmed gutta percha-Obtura II



Fig. 10.4c: Canal warmed gutta percha-Ultra fil



Fig. 10.4d: Canal warmed gutta percha technique-
Thermaprep plus



Fig. 10.4e: Canal warmed gutta percha technique-Element obturation system



Fig. 10.4f: Canal warmed gutta percha technique-Cordless E and Q plus



Fig. 10.4g: Canal warmed gutta percha technique-soft core



Fig. 10.4h: Flowable gutta percha-gutta flow

- b. Hybrid technique
 - c. JS-Quick-Fill
 - d. Ultrasonic Plasticizing.
- D. *Thermoplasticized Gutta Percha*
- i. Syringe Insertion
 - a. Obtura
 - b. Inject-R-Fill, backfill.
 - ii. Solid – Core Carrier insertion
 - a. Thermafil and Densfil
 - b. Soft Core and Three dec GP.

Apical – Third Filling

- A. Lightspeed simplifill
- B. Dentin chip
- C. Calcium Hydroxide.

Injection or “Spiral” Filling

- A. Cements
- B. Pastes
- C. Plastics
- D. Calcium phosphate.

Lateral Compaction of Cold Gutta Percha (Fig. 10.5 and Table 10.1)

- Most commonly taught and practiced method.
- *Technique encompasses* – 1st placing a sealer lining in the canal, followed by a measured primary point, which in turn is compacted laterally by a plugger – like tape-

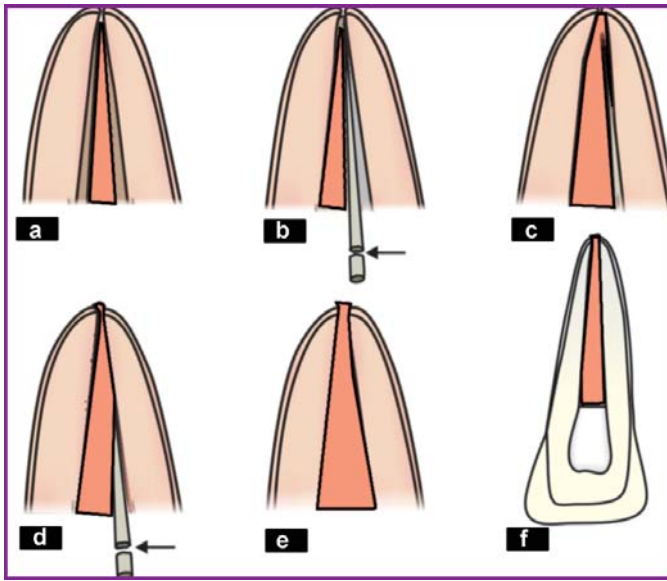


Fig. 10.5: Lateral compaction, multiple-point filling procedure

ring spreader used with vertical pressure to make room for additional points. The final mass of pts is severed at the canal's orifice with a hot instrument and final vertical compaction is done with a large plugger.

Criteria for lateral compaction:

- i. Final canal shape should be a continuous taper approaching the apical area, matching the taper of the spreader/plugger.
- ii. Spreader must reach 1 to 2 mm of the working length
- iii. Accessory GP cones must be smaller in diameter than spreader/plugger.

Table 10.1: Steps in lateral compaction, multiple-point filling procedure

Step 1: A spreader is selected which can reach to within 1.0 mm of apical constriction.

Step 2: A thin layer of sealer is made to line the canal walls as well as the tip of the previously selected master cone of gutta percha.

Step 3: The master cone is carried fully to within 1.0 mm of “apical stop” (Fig. 10.5a).

Step 4: A finger or hand spreader (Fig. 10.5b, arrow) is inserted to full depth and allowed to remain one full minute in place. This aids the gutta percha to compact laterally and somewhat apically.

Step 5: The spreader is removed by rotation and immediately replaced by first auxiliary point which has been previously dipped in the root sealer (Fig. 10.5c).

Step 6: The spreader (Fig. 10.5d, arrow) is returned to canal to laterally compact the increased mass of filling, read gutta percha and sealer. Secondary vertical compaction seals apical foramen.

Step 7: The spreader is again removed and is replaced by matching auxiliary gutta percha point within the root canal (Fig. 10.5e) Process continues until canal is totally obturated.

Step 8: All excess gutta percha and sealer are removed from the crown to below free gingival level. Vertical compaction completes the obturation of the root canal. This is followed by the placement of an intraorifice barrier, which is usually followed by a permanent restoration with adhesives replacing the structure of the crown (Fig. 10.5f).

Before embarking on the filling process, certain steps must be conducted:

Spreader Size Determination

- Of same apical instrument size or one size larger
- It should reach within 1 to 2 mm of the working length and not penetrate foramen

- A rubber stop should be placed on the shaft of the spreads to mark the WL minus 1mm.

Primary Point Size Determination (Fig. 10.6a)

- Standardized GP to be used (Fig. 10.3).
- Primary point should be selected to *match* the size of the *last instrument* used at the apex and should be tested in place and confirmed radiographically.
- GP should be *sterilized* in 5.25% NaOCl on 3% H₂O₂ on 2% chlorhexidine for 1-5 minutes.

Four methods can be used to determine proper fit of primary point:

i. *Visual Test*

- To test the point visually, it should be measured and grasped by cotton pliers at a position within 1mm short of the prepared canal length.
- Point is then carried into the canal until; cotton pliers touch the external reference point of the tooth.
- This *master point* should always be tried in a wet canal to simulate lubrication of a sealer.
- If working length is correct and point goes completely to position, the visual test has been passed.
- If termination of master point is within 1mm of WL, it provides for apical movement from vertical forces of compaction aided by lubrication from the sealant.

ii. *Tactile Test:*

- It is based on *tactile sensation* and will determine, if point snugly fits the canal.
- If the apical 3 to 4 mm of the canal have been prepared parallel, some degree of force is required to seat the point, and to dislodge it. This is known as “TUGBACK”

iii. *Patient Response:*

- It may be used in patients who are *not anesthetized* during the procedure.
- In non-vital pulp or at 2nd appointment, of a vital pulp, *the patient may feel the GP penetrate the apical foramen.*
- *Adjustments* can be made till the patient is *comfortable.*
- A very good test when position of foramen cannot be accurately determined by the radiograph or tactile sensation.

iv. *Radiographic Test:*

- After visual and tactile tests, the position of master point to be checked by *final test* - Radiography.
- Film must show the *point extending to within 1mm from the tip of the preparation.*
- Radiograph will *also show:* (a) Correct WL
(b) Curvature of the canal (c) Whether an apical perforation developed.

Drying the Canal (Figs 10.6b and c)

- Absorbent paper points to be used to absorb moisture or blood.
- Larger paper points to be followed by smaller paper points until full length is achieved.
- Any *bleeding should be stopped*, the blood irrigated from the canal, and care should be taken to *avoid penetrating the final paper point beyond the apex*.

Mixing and Placement of the Sealer

a. *Mixing:*

- Sterile slab and spatula to be used.
- One or two drops of liquid are used and the cement is mixed according to the manufacturer's directions.
- Cement should be *creamy* in consistency but quite heavy. It should not be mixed too thin, nor too viscous that it will not flow between the gutta percha points or penetrate accessory or lateral canals.

There are 2 tests to check the consistency of the mix:

- i. *String test:* The cement should string out at least an *inch* when spatula is lifted from the mix.
- ii. The consistency of the mix is considered ideal when it can be held for 10 secs on an inverted spatula *without dropping off*.

b. *Placement of sealers:*

Various methods can be used:

- i. Sealer can be "*pumped*" into the canal with *gutta percha point*.



Fig. 10.6a: Primary point size determination or selection of the master cone

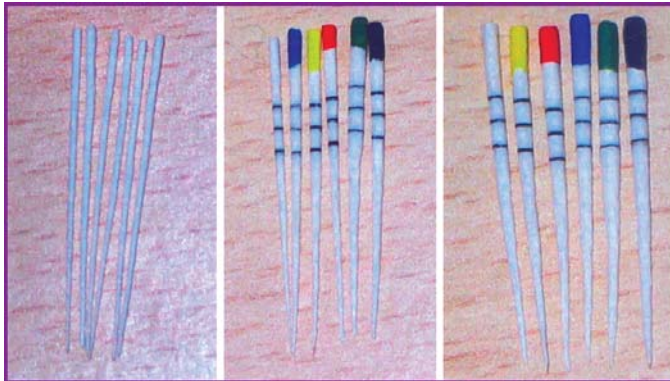


Fig. 10.6b: 2%-4%-6% standardized absorbent points



Fig. 10.6c: Drying the canal using paper points

- ii. *File or reamer* can be used, which is twirled counter clockwise, pumped up and down and wiped against all the walls.
- iii. *Rotary on spiral paste fillers* can be used clockwise in one's fingers or very slowly in a hand piece.

Placement of the Master Point

- The premeasured primary (Master/Initial) point is now coated with cement and slowly moved to full working length. Sealer acts as lubricant.
- Patient may experience some minor discomfort from this procedure as air is evacuated from the canal through the foramen.

MULTIPLE – POINT OBTURATION WITH LATERAL COMPACTION

Steps are as follows:

- i. After the *primary point* is *cemented* the butt end extending into the coronal cavity, should be removed with a hot instrument or scissors.
- ii. The *premeasured spreader* is then *introduced* into the canal and with a rotary vertical motion, slowly moved apically to *full penetration*. The wedging force between the canal walls and the gutta percha results in deformation and molding of GP towards opposite canal walls, thus creating space.
- iii. The *Spreader* is *then removed* with the same *reciprocating motion*, followed by immediate insertion of the *first Auxiliary point* in the space left by the spreader.
- iv. This is followed by more spreading and more points, until the entire root cavity is filled.
- v. To ensure a *cohesive filling*, *additional sealer* should be added with each point as a lubricant to facilitate full penetration.
- vi. *Obturation* is *completed* when spreader can no longer penetrate the filling mass beyond cervical wire.
- vii. At this point, *the protruding points* are *severed at the orifice* of the canal with a *hot instrument* Vertical compaction a *plugger* will ensure tight **GP mass** and more effective seal against coronal leakage.
- viii. All sealer and GP: removed from chamber – RC – Temporary/Final filling.

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Symbol *f* and *t* refer Figure and Table respectively.